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Caddy Plug-In Hybrid Concept

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BY ELIZABETH SVOBODA

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## 82 Masters of Rescue

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## 90 Finding Your Inner Garage

PM and *Garage Mahal* turn a two-car space into a home fitness center.

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**86 The Fast and the Frugal** Sensible vehicles don't have to be dull. In the ultimate test of functionality, efficiency and (especially) fun, PM pits a sporty subcompact against an exotic motorcycle. The results may surprise you. BY BEN STEWART

### ON THE COVER

To dramatize the threat posed by cyber attacks, pyrotechnics expert Drew Jiritano attached an explosive squib to the back of a laptop computer; stop-motion photography captured the results. PM's digital imaging specialist Anthony Verducci completed the concept.



## diy

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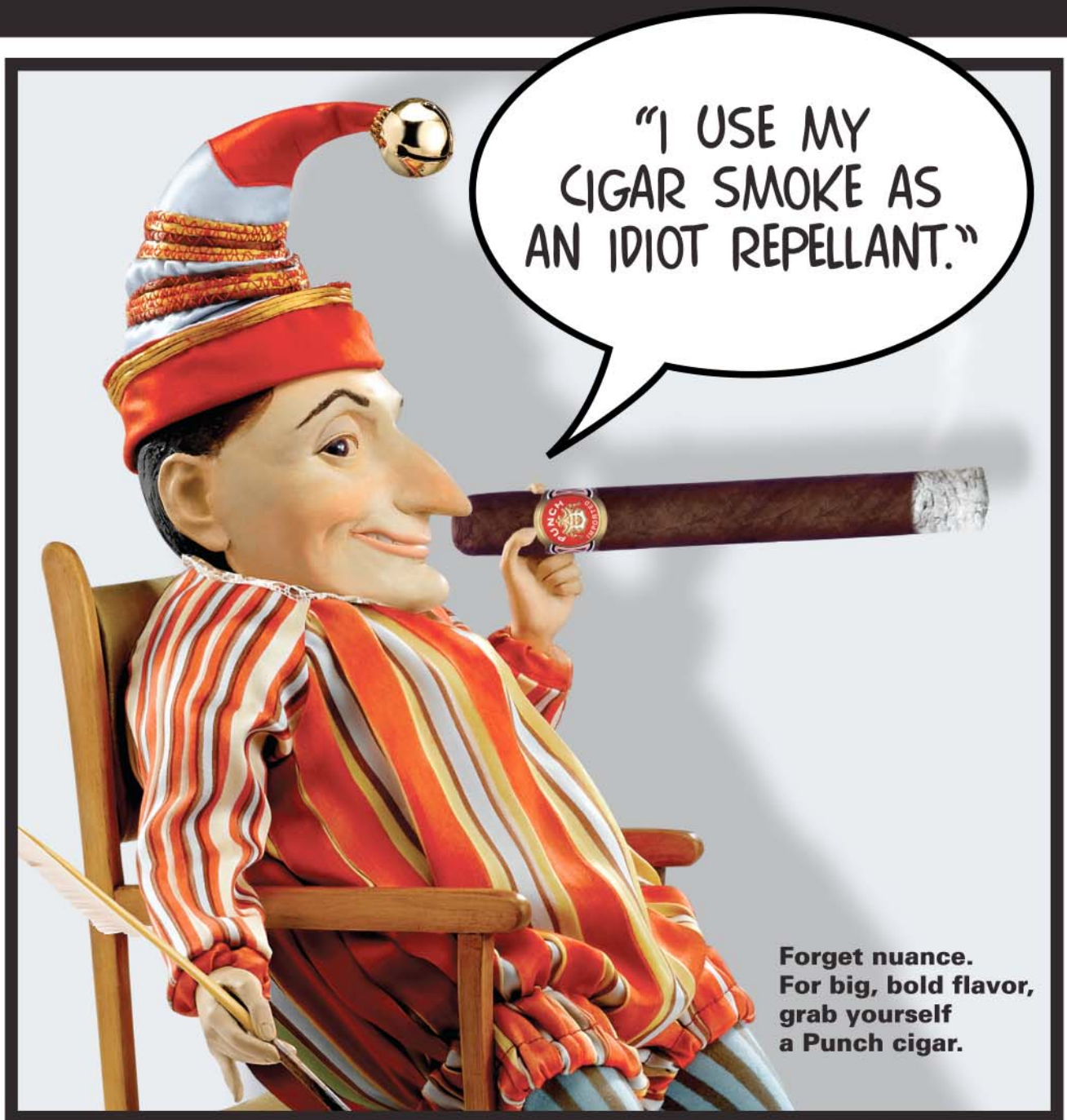
### DAVID E. COLE

*Chairman, Center for Automotive Research*  
David Cole says he can't predict what 2009 has in store for the auto business as a whole, but, using his knowledge of the automotive environment, he is advising government and media groups on changes in the industry and what they imply for the future. One current project is to explain the turbulent times in the automotive sector to bankers making lending decisions.





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**JOHN MCKINNEY**  
ANAHEIM, CA

**EDITOR'S UPDATE:** Since our February issue hit newsstands, Jupiter Direct proponents met with President Obama's transition team, administrator Michael Griffin has left NASA, and the current plans for human spaceflight have been placed under review. For continuing coverage of the future of NASA, visit [popularmechanics.com](http://popularmechanics.com).

## PM Lab vs. TV Claims

I so enjoyed your article on products, "If You Act Now ..." A friend gave me a set of the as-seen-on-TV Aqua Globes you tested, and though they are a good idea, I found one of the stems so tight I couldn't even get water into the bulb.

**M.E. DOHERTY**  
DALLAS, TX

## Larger Than Life

Thanks for supersizing me—I truly enjoyed your story "Mega Vehicles." I only wish you had highlighted the Antonov An-225 Mriya as the world's largest aircraft. Getting a close glimpse of that colossal jet would have provided a titanic ending to the story.

**GREGORY T. DRAKE**  
MOUNTAIN HOME, ID

## PM LETTERS

### Future in Space

As a 40-year space program veteran, I was both interested and saddened by February's story about competing proposals for the next generation of launch vehicles, "NASA and Its Discontents." It seems much of the cultural arrogance I experienced as a graduate student in the '60s still exists today. A better solution than NASA's Ares proposal would be to take the already-proven enhanced expendable launch vehicles as the basis for a new personnel launch vehicle. It's sad to see Dr. Griffin defending a badly flawed program, and I hope he's given his walking papers.

**CHARLES P. KELLEY**  
OKLAHOMA CITY, OK

The Jupiter Direct will never get off the ground. Why would NASA throw away four years

**ISSUE**  
**02/09**

Readers responded to stories on future NASA launch vehicles, PM lab tests and the world's largest vehicles.

of work and investment on Ares? NASA evaluated the Jupiter proposal and found it seriously wanting on a number of points, including safety and cost. History will catch up with Jupiter Direct and the plan will be long forgotten by the time Project Constellation is on the moon.

**JIM MCDADE**  
VESTAVIA HILLS, AL

Your NASA article shows the agency's management is still biased toward higher risk revolution versus evolution. If a new system is based on existing systems, they feel they aren't inventing anything new or



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## April Online Features

### DIY RALLY 2009

Calling all inventors! It's that time of the year, when POPULAR MECHANICS readers retreat to their garages, sheds and yards to put the finishing touches on their 2009 DIY Rally entries. Projects can be anything from a handcrafted treehouse to a personal robot to an electric go-kart. (Note: Your project must be built by the deadline.) The best reader projects will be featured in a magazine story this summer. Submission deadline is April 1, 2009. To submit pics, video and description, go to [popularmechanics.com/diyrally2009](http://popularmechanics.com/diyrally2009).



### HOLLYWOOD F/X

For the latest behind-the-scenes explanation of how the studios render special effects for tech-intensive movies, including *Watchmen*, *Star Trek* and *Terminator Salvation*, go to [popularmechanics.com/digitalhollywood](http://popularmechanics.com/digitalhollywood).



### APOLLO TURNS 40

In 1969, *Apollo 11* made history when it ferried three astronauts to the moon.

We continue our long history of Apollo coverage by speaking with people involved in the *Apollo 11* mission. [popularmechanics.com/apolloturns40](http://popularmechanics.com/apolloturns40).

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**Actually, it's called a pulse plug—here's why its technology should be in your engine.**

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This new technology—with its eight patents—is based on plasma research supported by the world famous Sandia National Laboratories—and yes, that's *definitely* rocket science.



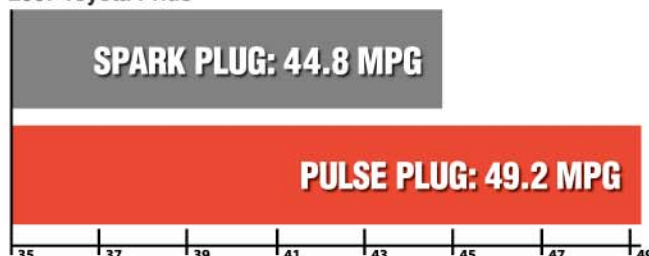
See the difference in technology: compare the cross section of a typical spark plug above, with that of the new pulse plug below.



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# Tech Watch

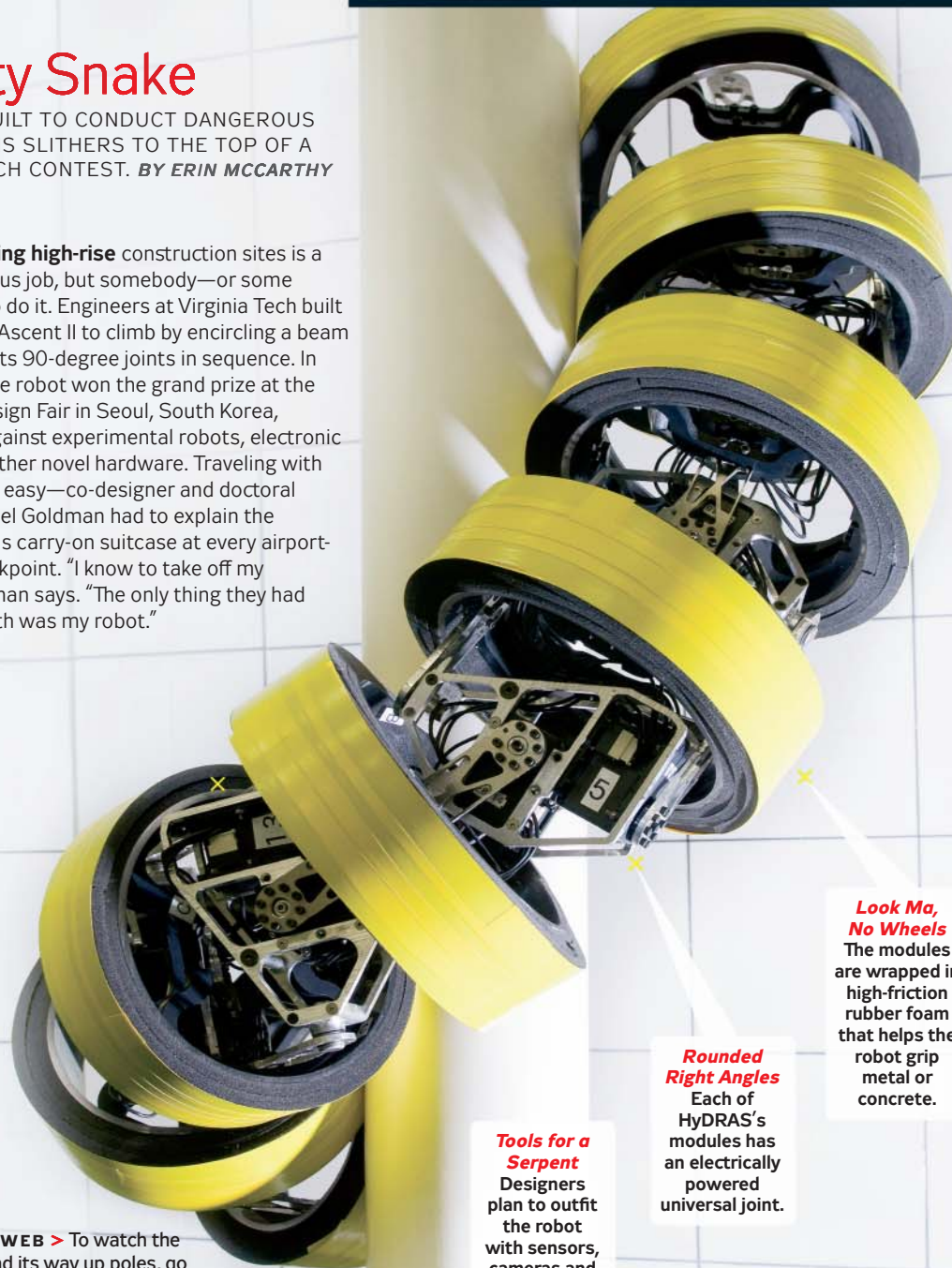
## Safety Snake

A ROBOT BUILT TO CONDUCT DANGEROUS INSPECTIONS SLITHERS TO THE TOP OF A KOREAN TECH CONTEST. **BY ERIN MCCARTHY**

→ **Inspecting high-rise** construction sites is a dangerous job, but somebody—or some robot—has to do it. Engineers at Virginia Tech built the HyDRAS-Ascent II to climb by encircling a beam and twisting its 90-degree joints in sequence. In December, the robot won the grand prize at the Capstone Design Fair in Seoul, South Korea, competing against experimental robots, electronic gizmos and other novel hardware. Traveling with HyDRAS isn't easy—co-designer and doctoral student Gabriel Goldman had to explain the contents of his carry-on suitcase at every airport-security checkpoint. "I know to take off my shoes," Goldman says. "The only thing they had a problem with was my robot."



**ON THE WEB** > To watch the robot wind its way up poles, go to [popularmechanics.com/robotsnake](http://popularmechanics.com/robotsnake).



**Look Ma, No Wheels**  
The modules are wrapped in high-friction rubber foam that helps the robot grip metal or concrete.

### **Rounded Right Angles**

Each of HyDRAS's modules has an electrically powered universal joint.

### **Tools for a Serpent**

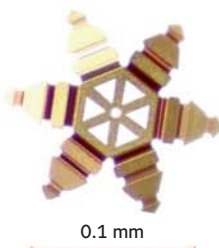
Designers plan to outfit the robot with sensors, cameras and a tool manipulator.





### GRIPPING MEDICAL NANOTECH

+ Doctors usually resort to invasive biopsies to fetch body tissues from patients. But engineers at Johns Hopkins University in Baltimore have developed a magnet-guided "microgripper," the size of a speck of dust, that can do the job gently. The six chromium-copper fingers of the gripper are kept open by a layer of plastic, which softens when doctors heat the surrounding tissue, closing the grabber's fingers around a sample.



## Avatars of Exercise

One of the trickiest parts of exercise is maintaining good form to activate the right muscles. A new system developed by Amsterdam-based Motek Medical displays a virtual body double showing exactly which muscles are being used and how much force they're generating—in real time. Users of the Human Body Model wear a suit with 47 reflective markers that are illuminated by infrared strobe lights that flash several hundred times a second. Eight high-speed cameras and force sensors in the floor capture data that is used to create models of the user's movements and the force that those motions generate. The system is being tested in Israel to help patients recover movement after a stroke; it could also provide an early diagnosis of conditions such as muscular dystrophy.



### Experimental Eagle

+ NASA recently finished a program that may aid the return of supersonic commercial flights. During tests at NASA's Dryden Flight Research Center in Edwards, Calif., two uniquely modded F-15 Eagles flew as close as 100 ft apart to measure the leading aircraft's shock waves, while the lead pilot reconfigured the wings and direction of the engines' nozzles. Shock waves cause sonic booms that limit flights over populated areas. The NF-15B (above) is ideal for studying airplane geometry because its canards, borrowed from the horizontal stabilizers of an F-18, can be adjusted in flight.

### THE FRIENDLY NEIGHBORHOOD WIND TURBINE

+ A new wind turbine promises to be a fit for any home. Michigan-based Cascade Engineering's 7-ft-dia. turbine has a ring around its blades that minimizes vibration and helps keep noise to less than 35 decibels—barely a whisper—no matter what the wind speed. The \$10,000 unit promises up to 2000 kilowatt-hours per year in high-wind areas, about 20 percent of the electricity used by a typical home.



## NEWSBRIEFS

Reports From the Edge of Science

Compiled by Alex Hutchinson

### FULL-SPECTRUM E-LITERACY

+ Reading devices with electronic paper, or e-books, are catching on, but so far they're still black-and-white. Researchers at the University of Toronto recently demonstrated a new photonic crystal screen whose pixels can each cover the entire spectrum, switching colors in about a tenth of a second.

### Hard as Steel, Easy as Plastic

+ A new plastic that conducts electricity has been developed by German scientists at the Fraunhofer Institute for Manufacturing Technology and Applied Materials Research. The composite material combines the electrical and thermal properties of metal with the easy manufacturing of plastic. Researchers have developed conductive polymers suitable for wires and circuit boards, but the new, lightweight material could find wider use in vehicles. For example, aircraft could use lightweight, conductive fuselage panels that dissipate the charges from midair lightning strikes.



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THE

# GOODS

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## HOW PROPANE TANKLESS WATER HEATERS WORK



Easily installed, **propane tankless water heaters** efficiently heat on demand and do not store heated water for later use.

When there is a demand for hot water, the tankless model senses the demand and starts the heating process. The water flows through a heat exchanger and is heated to the designated temperature by the burner. A heat exchanger is a device that transfers heat from one source to another and in this case, it transfers heat generated by a propane burner to the water that is being called for at your faucet, shower or washing machine. The propane burner is activated by a demand for hot water anywhere in the home. So when you turn on your hot water tap, the incoming water circulates through the heat exchanger, which heats the cold water to your desired temperature as it passes through the exchanger.

[usepropane.com](http://usepropane.com)

## SAVE MONEY

Tankless water heaters **cost up to 60% less** to operate than a standard electric unit and typically last 10-15 years longer than a standard unit (this is due to corrosion of tank units). For units installed in 2009, Federal tax credits are available, and propane customers in several states can receive rebates for switching out electric water heaters.



## SAVE ENERGY

The average American family can **save 10-20% of its daily water use** with a tankless unit. With tankless units homeowners save energy, lower greenhouse gas emissions and reduce their carbon footprint. In fact, propane tankless water heaters release 63% less carbon emissions than electric water heaters. Propane tankless water heaters are Energy Star qualified (electric water heaters do not qualify) and its just another reason that the coolest new thing for your home is actually hot!



## SAVE SPACE & TIME

Because they heat water on demand, tankless units provide a nearly endless supply of hot water. Additionally, units provide ample floor space **savings of 12-16 square feet**. Contact your local propane retailer and plumber/HVAC contractor to get one installed.



*Tankless water heater*

**Equal throughout,  
93% less space.**



*50-gallon water heater*

For hot water we can  
all feel good about, install  
a tankless water heater.



This should warm you up right away: While delivering endless hot water, a propane tankless water heater can lower water heating bills up to 60 percent compared to an electric water heater. In fact, an ENERGY STAR-rated propane tankless water heater is so efficient, it can save 10 to 20 percent in daily water use. Plus, it's easier on the environment, with half the carbon emissions. You may also qualify for tax incentives. Start feeling warmer today. Learn more at [usepropane.com](http://usepropane.com).



**PROPANE**  
EXCEPTIONAL ENERGY®





# Soft Landing

SURVIVING THE WATERY CRASH OF AN AIRPLANE WITH NO ENGINES WAS NO MIRACLE. BY THE EDITORS

## 1 Airplanes are made to survive total engine loss.

✦ How can computer-controlled planes steer without power? Auxiliary power units and ram-air turbines that drop from the fuselage can power the hydraulics that control an airplane. Damaged engines can provide a trickle of power from the windmilling of their blades as they move through the air.

## 2 Air emergencies are more survivable at higher altitudes.

✦ Flight recorders show that the airplane reached a maximum altitude of 3200 ft. If the bird strike had happened lower, just after takeoff, the plane probably would have plunged into the rough and frigid waters of Long Island Sound at a very high speed, in a spot where rescue would have taken longer.

## 3 Rivers can make decent runways.

✦ Capt. Chesley Sullenberger determined that he did not have enough control to return to LaGuardia. Without the engines working in reverse to slow the plane, he might have overshot the runway. If you have to put a jet down, the Hudson River is a close-to-ideal venue. It's wide, the water is relatively calm and rescuers are close at hand.

## 4 Ditched airplanes don't sink fast.

✦ Airplane fuselages are designed to keep air in, and that design helps keep water out. Aviation designers also include systems that can delay sinking. Airbus A-320 cockpits are equipped with a button that seals the lower openings on the plane's fuselage, like the avionic ventilation ports and inlet for the ram-air turbine.

## 5 Training for the unlikely can save the day.

✦ Ditching into water is a rare event, but commercial airline crews prepare for it. Likewise, NY Waterway ferry crews train to assist and treat distressed boaters or swimmers. They quickly retrieved 142 of the Airbus's 155 passengers and crew from the icy water.



The safe landing of US Airways Flight 1549, shown here as the plane is hoisted from the frigid Hudson River, was aided by luck, training and engineering.



Time  
Machine  
MARCH  
1916



The need to protect the nation's infrastructure has always bred fresh thinking. In March 1916, as the United States mullied its entry into World War I, *POPULAR MECHANICS* reported on a New York inventor who proposed arming train cars with heavy artillery. These mobile gun platforms would be similar to ones used by Germany and would be deployed to guard America's coasts and, PM wrote, defend "our inland cities, railway centers and industrial points." (The idea was never adopted.) Modern technology brings both new threats and the plans to thwart them: Today's security pros are trying to protect the U.S. from cyber attacks that exploit our infrastructure's deep reliance on information technology (see "Weapon of Mass Disruption," page 76.) — ALLIE HAAKE



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What a dramatic difference. We love our  
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Liquidators for the best pricing around."*

**Mr. B., Ashland, MA**



**Bellawood Brazilian Cherry**

**Dream Home 6MM Norway Oak laminate flooring with  
10 year warranty (6NO) .....78¢ sq.ft.**

**Lisbon Cork Sunset Cork flooring with 25 year warranty  
(CKML) .....\$1.29 sq.ft.**

**Supreme Bamboo 5/8" x 3 3/4" prefinished flooring with  
15 year warranty (SPBAMHN) .....\$1.99 sq.ft.**

**Schön Bourbon County Oak easy click installation flooring  
with 25 year warranty (QC06BB) .....\$2.99 sq.ft.**

**Casa de Colour 1/2" x 2 1/4" Golden Oak prefinished flooring  
with 25 year warranty (PRQG01).....\$2.99 sq.ft.**

**Ty Pennington 5/8" x 3 3/4" Sambucca stained bamboo  
prefinished flooring with 30 year warranty (TPBAMSM)  
.....\$3.19 sq.ft.**

**Bellawood 3/4" x 2 1/4" Rustic Red Oak prefinished flooring  
with 50 year warranty (HUSR02RV) ..... \$3.89 per sq.ft.**

**Virginia Mill Works 1/2" x 5" Jamestown Plank handscraped  
prefinished flooring (HSJTP5).....\$3.99 sq.ft.**

**Builder's Pride 9/16" x 3" Natural Aztec Cherry flooring with  
25 year warranty (PRAZ3S916V) .....\$3.99 sq.ft.**

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PM 04 09



## MIRACLE PROJECTOR

A scientist turns a doctor's visit into a machine to help the visually impaired see. *BY AMBER ANGELLE*



+ During a trip to the optometrist 20 years ago, Elizabeth Goldring became inspired to create a seeing machine for the visually impaired. That's when Goldring, who is legally blind in one eye and partially blind in the other, first encountered a Scanning Laser Ophthalmoscope. The SLO is a tool that uses an infrared laser to shine an image onto the retina, bypassing hemorrhages and other defects within the eye. The patient reports when he is able to see the image, allowing the examiner to identify areas of healthy and unhealthy retinal cells. During the test, her damaged eyes could clearly read words. "I had to have one of those machines," says Goldring, now

a senior fellow at MIT's Center for Advanced Visual Studies. However, the cumbersome, \$100,000 SLO wasn't practical outside doctors' offices. She has collaborated with Robert Webb, inventor of the SLO and a physicist at Harvard University's Schepens Eye Research Institute, to create a mobile version called the Retinal Imaging Machine Vision System. The new device substitutes LEDs for the costly laser to illuminate a screen that focuses visual data from a computer or camera as a full

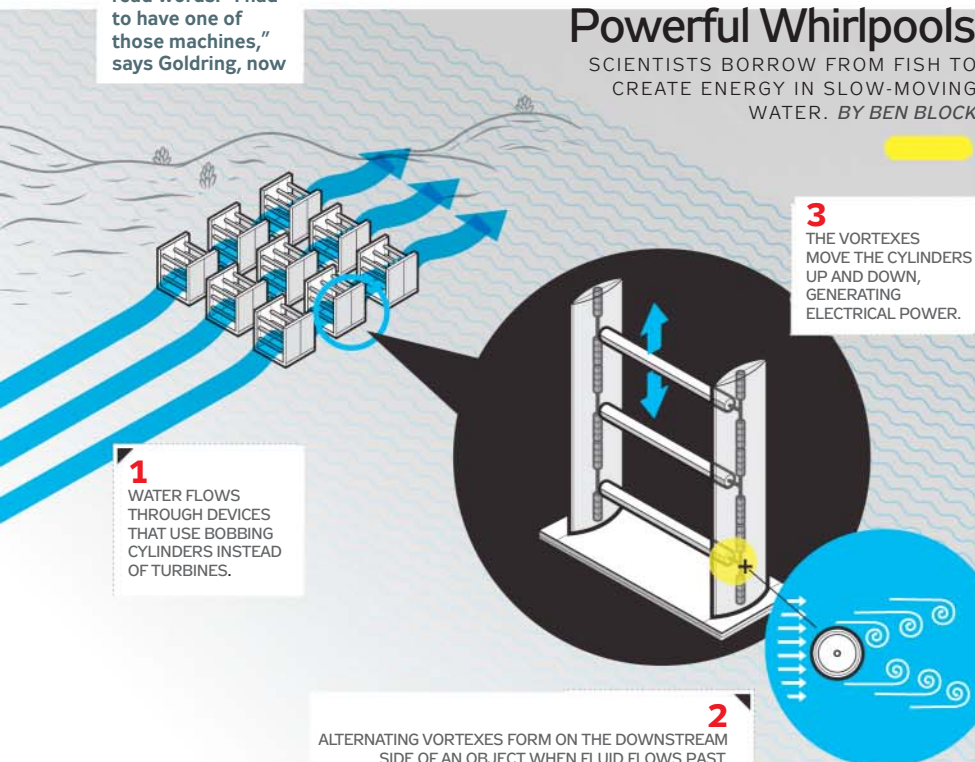
image onto the retina. "It's like a video projector," Webb says. Their latest prototype is a nondescript, 5-in.-wide box with a digital camera attached. By manipulating the camera's zoom, Goldring is able to recognize faces and distinguish objects. She plans to begin testing the portable Seeing Machine Camera at the Joslin Diabetes Center Eye Institute in Boston. "With this device I can see when my daughter is smiling," Goldring says.



**Landing on the deck** of an aircraft carrier takes quick reflexes, sharp mental focus and cool daring. But does it require a pilot? This fall Northrop Grumman will start flight testing the first unmanned strike airplane created to operate from a carrier. The stealth X-47B's 62-ft bat wings fold in to reduce overall span to 31 ft for storage. And that's no cockpit: The air intake is, almost mockingly, in the same place as a window in a manned aircraft. The X-47B's sea trials on a carrier are planned to begin in late 2011.

## Powerful Whirlpools

SCIENTISTS BORROW FROM FISH TO CREATE ENERGY IN SLOW-MOVING WATER. *BY BEN BLOCK*



→ Hydropower researchers at the University of Michigan are borrowing strategies from fish to maximize the energy that can be harvested from slow-moving water. For example, trout use spinning eddies that form on both sides of a stationary object, like a rock, to help conserve energy as they swim upstream. The vortexes that form alternate from one side of the rock to the other, so fish swimming upstream slalom between these whirlpools. Schools also use vortexes created by the fish ahead to conserve energy when swimming upstream.

The University of Michigan team's design harnesses these alternating vortexes: Aluminum cylinders joined to built-in electromagnets form a ladder-shaped device. As flowing currents swirl past a cylinder, the vortexes that form above and below push and pull the cylinders to generate electricity. Inventor Michael Bernitsas estimates the bobbing

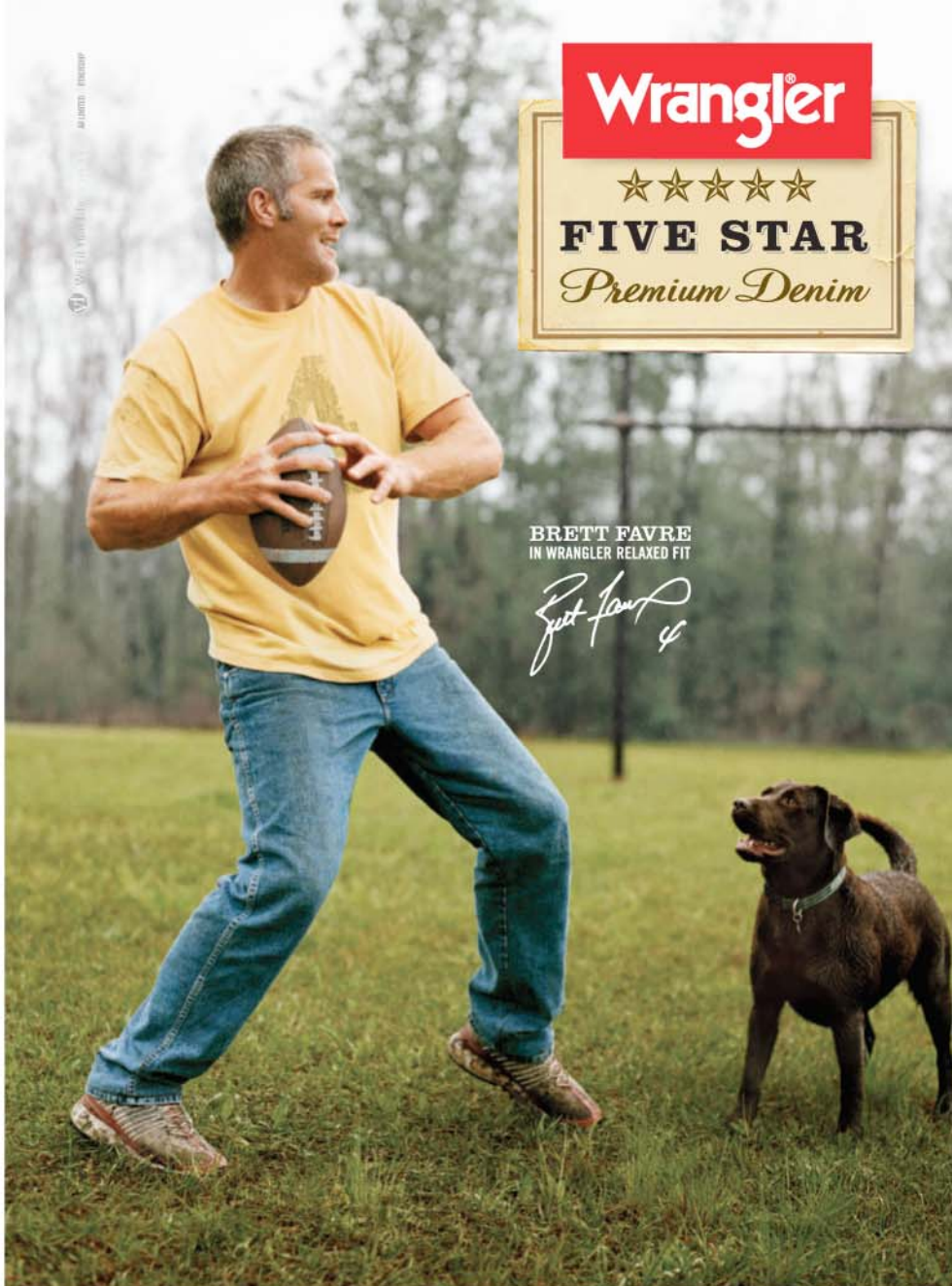




The revolutionary X-47B (artist's depiction, below) was revealed to the public late last year.



action can yield 51 watts per cubic meter at water speeds of 3 knots, depending on the number and size of the cylinders. The device, known as Vortex-Induced Vibrations for Aquatic Clean Energy, or VIVACE, attracted Navy interest for its potential to generate power at flow speeds slower than the 5-knot minimum of most turbines. To maximize the system's efficiency, Bernitsas draws insight from the anatomy of fish. Sandpaper-like surface roughness on the cylinders mimics scales to form more energetic whirlpools. Flexible plates designed like a fish's tail could speed up cylinders in very slow-moving water or decrease the cylinder movement, which would help to protect aquatic life. "We may design a tail that's adjustable and has sensors, but I'm not anywhere near that yet," Bernitsas said. "Simply, we are not as smart as fish at this point."



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# Amish mantle and miracle invention help home heat bills hit rock bottom

*Miracle heaters being given away free with orders for real Amish fireplace mantles to announce the invention that helps slash heat bills, but Amish craftsmen still under strain of winter rush force household limit of 2*

**Save money: only uses about 8¢ electric an hour; so turn down your thermostat and never be cold again**

By MARK WOODS  
Universal Media Syndicate

(UMS) Everyone hates high heat bills. But we're all sick and tired of simply turning down the thermostat and then being cold.

Well now, the popular HEAT SURGE® miracle heaters are actually being given away free to the general public for the next 7 days starting at precisely 8:00 a.m. today.

The only thing readers have to do is call the National Distribution Hotline before the 7-day deadline with their order for the handmade Amish Fireplace Mantle. Everyone who does is instantly being awarded the miracle heater absolutely free.

This is all happening to announce the HEAT SURGE Roll-n-Glow® Fireplace which actually rolls from room-to-room so you can turn down your thermostat and take the heat with you anywhere. That way, everyone who gets them first can immediately start saving on their heat bills.

Still in time for cold weather, portable Amish encased fireplaces are being delivered directly to the doors of all those who beat the deadline.

These remarkable fireplaces are being called a miracle because they have what's being called the 'Fireless Flame' patented technology that gives you the peaceful flicker of a real fire but without any flames, fumes, smells, ashes or mess. Everyone is getting them because they require no chimney and no vent. You just plug them in.

The Fireless Flame looks so real it amazes everybody because it has no real fire. So



**■ GENUINE AMISH MANTLES MADE IN THE USA:** Everyone wants to save money on heat bills this winter, so entire Amish communities are working from the crack of dawn to finish. These fine real wood Amish made fireplace mantles are built to last forever. The oak mantle is a real steal at just two hundred ninety-eight dollars because all those who beat the order deadline by calling the National Hotline at 1-800-918-4312 to order the fireplace mantles are actually getting the imported hi-tech Fireless Flame HEAT SURGE miracle heaters for free.

what's the catch? Well, soft spoken Amish craftsmen who take their time hand building the mantles have a process

that forces a strict household limit of 2 to keep up with orders.

"We can barely keep up ever since we started giving heaters away free. Since it's still really cold outside, everyone's trying to get them. Amish craftsmen are working their fingers to the bone to be sure everyone gets their delivery in time to save a lot of money," confirms Timothy Milton, National Shipping Director.

"These portable Roll-n-Glow Fireplaces are the latest home decorating sensation. They actually give you a beautifully redecorated room while they quickly heat from wall to wall. It's the best way to dress up every room, stay really warm and slash

your heat bills all at the same time," says Josette Holland, Home Makeover Expert.

And here's the best part. Readers who beat the 7-day order deadline are getting their imported hi-tech miracle heaters free when encased in the Amish built real wood fireplace mantles. The mantles are being handmade in the USA right in the heart of Amish country where they are beautifully hand-rubbed, stained and varnished.

You just can't find custom made Amish mantles like this in the national chain stores. That makes the oak mantle a real steal for just two hundred ninety-eight dollars since the entire cost of the miracle heater is free.

This free giveaway is the



**■ JUST ANNOUNCED:** The Heat Surge miracle fireplace has earned the prestigious Good Housekeeping Seal. The product has earned the Seal after evaluation by the Good Housekeeping Research Institute.



## HEAT SURGE® Fireless Flame

**How It Works:** The HEAT SURGE miracle heater is a work of engineering genius from the China coast so advanced, you simply plug it into any standard outlet. It uses only about 8¢ of electric an hour on the standard setting. Yet, it produces up to an amazing 5,119 BTU's on the high setting. So watch out, a powerful on board hi-tech heat turbine silently forces hot air out into the room from the vent so you feel the bone soothing heat instantly. It even has certification of Underwriters Laboratories coveted UL listing. It also comes with a limited full year replacement or money back warranty plus a 30-Day Satisfaction Guarantee.



best way to slash heating bills and stay warm winter after winter. The HEAT SURGE Roll-n-Glow Fireplace gives you zone heating and all the beauty and warmth of a built-in fireplace but rolls from room-to-room so it can also save you a ton of money on heating bills.

Even people in California and Florida are flocking to get them so they may never have to turn on their furnace all winter. And since it uses

only about 8 cents of electric an hour on the standard setting, the potential savings are absolutely incredible.

"We are making sure no one gets left out, but you better hurry because entire communities of Amish craftsmen are straining to keep up with demands. For now, we are turning away all dealers in order to let readers have two per household just as long as they call before the dead-

# How to get 2 free heaters

The National Toll Free Hotlines are now open. All those who beat the 7-day order deadline to cover the cost of the Amish made Fireplace Mantle and shipping get the HEAT SURGE miracle heater free.

A strict limit of 2 per household has been imposed. Since some home woodworkers want to build their own mantle piece, they are letting people get the imported miracle heater alone for just \$249. Or, with the Amish made mantle you get the miracle heater free.

Use the map below to locate the weather zone you live in and call the Hotline number for your zone.



Claim Code: FP8064

**EVERYONE LIVING IN THE  
Frigid Zone: 1**  
START CALLING AT  
8:00 A.M. TODAY  
1-800-918-4312

**EVERYONE LIVING IN THE  
Cold Zone: 2**  
START CALLING AT  
8:30 A.M. TODAY  
1-800-716-2513

**EVERYONE LIVING IN THE  
Frost Zone: 3**  
START CALLING AT  
9:00 A.M. TODAY  
1-800-695-3077

FOR HEAT SURGE, LLC 3939 EVERHARD RD., CANTON OH 44709

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**ON THEIR WAY:** A surge of rush orders have turned country roads into pipelines to the big city delivery system. Everybody wants a fireplace that comes fully assembled with a handmade Amish mantle in oak or cherry finish and gets delivered by truck right to your door. All you do is plug it in.

line," confirms Milton.

It's a really smart decision to get two right now because for only the next 7 days you get both miracle heaters free. That's like putting five hundred bucks right in your pocket and you can save even more money on your monthly heating bills.

"Everyone's calling to get one but those who really want to save a lot of money are surprising the whole family by getting two. So when lines

are busy keep trying or log onto [amishfireplaces.com](http://amishfireplaces.com). We promise to get to every call. Then we can have a delivery truck out to your door right away with your beautiful Heat Surge Roll-n-Glow Fireplace," Milton said.

"You'll instantly feel bone soothing heat in any room. You will never have to be cold again," he said. ■

On the worldwide web:  
[www.amishfireplaces.com](http://www.amishfireplaces.com)

*Rolls anywhere to throw an instant heat wave with no chimney, no vents, no wood and no smoke*



**EASILY ROLLS ANYWHERE:** This is the portable Roll-n-Glow® Fireplace that easily rolls from bedroom to living room to keep you warm. No vents, no chimney and no tools. Just plug it in.



**SAVES ON BILLS:** Everyone can get low bills and stay warm and cozy. The new Roll-n-Glow Fireplace saves a ton of money and makes your front room look like a million bucks.



**SAFE FLAME:** The Fireless Flame looks so real it fools everyone but there is no real fire. That makes the flame window safe to the touch under the watchful eye of a parent. It's where the kids will play and the cat and dog will sleep.



**FREE:** Get this \$249 miracle heater free. It is being given away free to all who beat the 7-day order deadline for your choice of the oak or cherry finish Amish Mantles. The free heater comes already encased.



# The World's Space Fleet

MEET THE SPACECRAFT THAT COULD INHERIT THE SPACE SHUTTLE'S JOB OF FERRYING SUPPLIES INTO SPACE.

BY MICHAEL BELFIORE

→ **The space shuttle** is due for retirement in 2010, and NASA's next spaceship, *Orion*, won't be available until at least 2015. That will leave a five-year gap during which NASA astronauts and space-station cargo will be grounded unless they find other ways to get to orbit. In the past, NASA has cadged rides off its former arch-rival, the Russian Federal Space Agency, and its Soyuz (for astronauts) and Progress (for cargo) spacecraft. But relations between the U.S. and Russia are cooling, raising the very real prospect that Congress will forbid NASA to buy spaceflights from Russia. NASA has stepped up its support of two U.S. companies, Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation, that hope to have unmanned cargo spaceships ready for launch by 2010. (See details below.) Even if these companies succeed, NASA will still have to rely on Soyuz for manned flights. But maybe not for long. Here's a roundup of seven rides to low Earth orbit besides the space shuttle and Soyuz that could be available for space-station flights.

2003

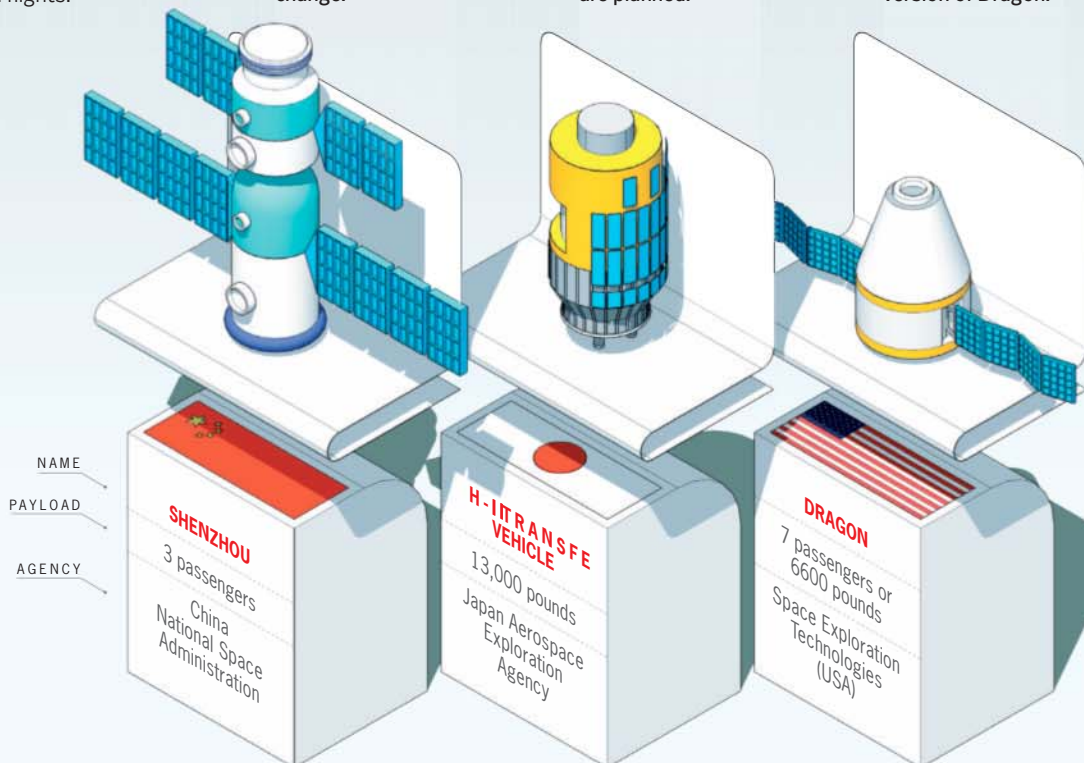
↓  
China became Earth's third space-faring nation with this vehicle's first launch in 2003. Since then, these single-use craft, loosely based on Soyuz and boosted by China's Long March 2F rockets, have been flying *taikonauts* to orbit once every two or three years, making the Shenzhou the only vehicle besides Soyuz and the shuttle that could currently fly astronauts to the International Space Station. NASA and its Chinese counterpart have so far shown no signs of cooperating, but that could change.

2009

↓  
This unmanned ship was designed for transporting cargo to the International Space Station. The first of these expendable vehicles will launch this year aboard a new Japanese H-II/B rocket; no manned versions are planned.

2010

↓  
Dot-com millionaire Elon Musk founded Space Exploration Technologies, or SpaceX, to deliver affordable access to space, and he's been developing the Dragon and its Falcon family of rockets with the help of seed money from NASA. In December 2008, NASA went a step further and awarded SpaceX a \$1.6 billion contract to service the International Space Station with 12 cargo flights starting in 2010. SpaceX is also working on a crew version of Dragon.



2010

2014

2015

2020

AVAILABILITY

Orbital Sciences Corporation has also been receiving federal funding to develop alternate rides to orbit, and it too got a NASA contract in December to send cargo to the International Space Station. Orbital's contract is worth \$1.9 billion for eight launches aboard the Cygnus capsule, boosted by the company's Taurus II launcher, now in development. Current plans call for cargo flights only, but the company says manned flights wouldn't be out of the question if NASA requested them.

Lockheed Martin and Bigelow Aerospace are studying the conversion of existing hardware to launch Bigelow's Sundancer capsules to the firm's planned space stations. While not part of NASA's plans, the Atlas V 401 launcher and the proposed cargo and crew capsules could easily service the International Space Station.

The prosaically named (for now) Orbital Vehicle has been on Indian drawing boards since at least 2006, and the Indian space agency conducted unmanned re-entry tests in 2007 to gather hard data for a manned re-entry capsule. Actual construction is awaiting government approval for funding, making this the most speculative project of the bunch. The spacecraft would launch on India's Geosynchronous Satellite Launch Vehicle Mark III, now in development.

An unmanned cargo version of Europe's answer to the Russian Progress cargo ship, with three times the payload, arrived at the International Space Station for the first time last year, boosted by Europe's Ariane 5 launch vehicle. The European Space Agency is studying a four-person manned version dubbed the Crew Transport Vehicle, or CTV, for use in 2020.



ILLUSTRATION BY MAXIMUS CHATSKY



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# Upgrade



+ The **17-in. primary screen** features the widest color gamut we've seen on a laptop, resulting in more realistic images.

+ A built-in **stylus-operated tablet** allows for precise image touchups without separate equipment.

+ The **built-out 10.6-in. secondary screen** can keep tool palettes and IM windows from infringing on the main work space.

## Double Display

Tech aficionados love using multiple monitors—the second screen boosts productivity. But until now, such setups were reserved for the desk-bound. The **Lenovo ThinkPad 700ds (from \$3660)** is the first laptop with a slide-out secondary screen. This rig is priced for pro photographers, but the technology should eventually end up in more affordable machines. — **SETH PORGES**



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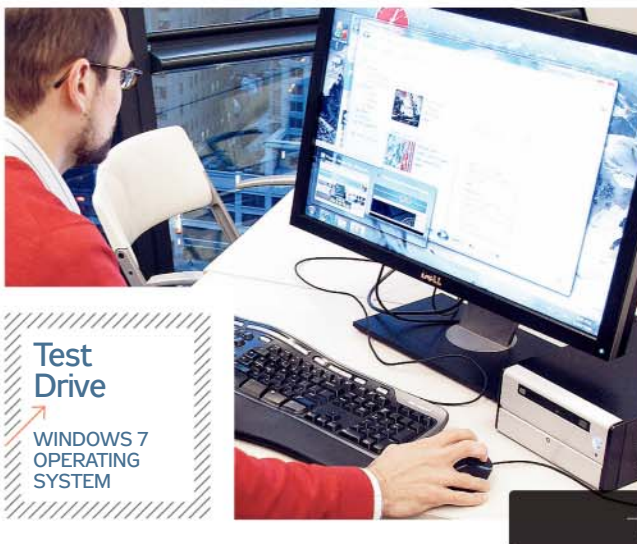
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P M U P G R A D E

wish list



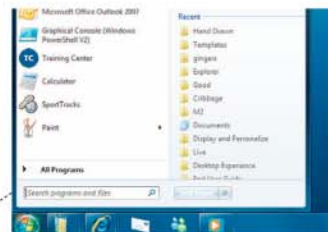
## Looking Beyond Vista

**To be honest,** I never really developed the visceral hatred for Microsoft's Vista operating system that many users seem to feel, but the sentiment is understandable. Vista is bloated and slow—and it took a back-seat-driver approach to security that could really get under your skin. ("Are you sure you want to launch this program?" "Are you really sure?") So less than two years after Vista's launch, Microsoft is preparing to launch Windows 7 sometime in the next year or two. In January, the beta of the new OS was released for all the world to try. My initial impressions are promising. It is faster at the important stuff—in my tests, Win 7 booted in around 45 seconds (Vista typically takes well over a minute)—and navigation is far more intelligent. But hey, it's a beta, so there's still much that could go wrong. And many more improvements are surely in the works. — **GLENN DERENE**

**Navigation** The new task bar gives full-screen previews and stacks up multiple windows for less clutter. "Jump Lists" put recent and important tasks into right-click menus.

**Networking** While still far from simple, networking is definitely more flexible with the new OS. "Homegroup" makes content sharing between PCs easier, but only if both are running Win 7.

**Next-Gen Features** Few computers take advantage of it now, but Win 7 natively supports multi-touch, which could eventually make touchscreen interaction as ubiquitous as mouse clicks.





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\*Results based on industry standard Sequence IVA wear test



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# Super Fly Gear

**There's something Zen-like about fly fishing.** It's just you, the river and whatever you carry with you. But novice anglers often make the mistake of overdoing the last part, loading up on unnecessary and expensive equipment. We tested the latest gear to find the best get-up for the trout fisherman who doesn't want to spend a small fortune. *BY BRIAN MCCLINTOCK*



## 1. ROD

**ST. CROIX IMPERIAL (\$150)** This graphite rod was tough enough to stand up to the abuse of novice testers, yet light and responsive enough to satisfy our veterans, performing as well as rods that cost twice as much.

## 2. LINE

**CORTLAND PRECISION PLATINUM (\$65)** For a fly line to work, it needs to float. Sadly, some lines start sinking after a day or two of use. Not this one—it's one of the most durable we've ever cast. We ran over it with a truck, and it still lasted a full season.

## 3. REEL

**SAGE 4500 CF SERIES (\$325)** When fighting a fish, the reel is your most important weapon, and one thing worth splurging on. Not only did we find this carbon-fiber reel to be extremely light and durable, but dialing its drag up and down was effortless, making it easy to tire out our catches before reeling them in.

## 4. BOOTS

**SIMMS FREESTONE (\$130)** When it comes to boot soles, fly fishermen used to have one choice: felt. But recent research suggests the material is a magnet for bacteria, and its use pollutes streams. These rubber-soled boots provide felt-like traction, without tainting tributaries.

## 5. WADERS

**SIMMS FREESTONE (\$200)** While you don't need to buy the most expensive waders on the shelf, be wary of the cheapest—we've seen waders leak after a single outing. This pair is made from a lightweight and durable synthetic and costs hundreds less than models with the same level of performance.

## 6. PACK

**FISHPOND ARROYO (\$60)** Casual day-anglers can ditch the traditional vest—compact packs are less bulky and make casting easier. This pack has plenty of places to stash lures and tools, and was comfortable through days of wading.





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The recession has been kind to pocket camcorders—the gadgets' low prices have made them commercial successes in an otherwise bleak business year. But technology moves fast, and these once no-frills cameras are now offering advanced features. Take the **Kodak Zx1 (\$150)**: It shoots in 720p high definition and is weather-resistant, built to withstand rain and dirt. It won't win any Oscars (as with any pocket camcorder, it's vulnerable to shaky hands), but for beach bums and snow-sporters, it's a no-brainer.



A magnetic socket holds onto nuts and hexhead fasteners that might otherwise get lost in nooks and crannies.

## Telescope Torque

Nuts and hexhead fasteners aren't always located in easy-to-reach places (laundry appliances, in particular, are notorious for their poorly placed fasteners).

The **Klenk 1/4-In. Adjustable-Length Magnetic Nut Driver (\$11)** has a telescopic shaft (the tool's total length can be set between 7.5 and 10.5 in.), allowing users to reach most out-of-the-way nuts and fasteners with a single tool.



## Pocket Presenter

While microprojectors have been trickling onto the market over the **past year**, their portability (and usefulness) has been limited—they need to be tethered to other devices to produce an image. The **Samsung MBP-200 Pico Projector** doubles as a portable media player, meaning it can be used to display videos or PowerPoints up to 50 in. diagonal on its own. In other words, it's everything you need to give a presentation, and it fits in a pocket. Samsung is mum on a release date and price, but look for it later this year.





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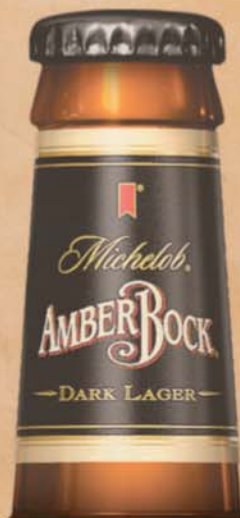
**PM**  
*Editor's  
Choice*



## Pre Approved

The past few years have seen a number of attempted iPhone killers. But without exception, they've all been hampered by unresponsive touchscreens, bulky designs or nonintuitive interfaces. So what makes the **Palm Pre (price not set)** different? It takes everything the iPhone does well—its interface is smooth and intuitive, and it's the only non-iPhone phone to feature a multitouch-capable touchscreen—and builds on it. Unlike the iPhone, the Pre has a slide-out keyboard (which, remarkably, doesn't add a significant amount of bulk), it can multitask, and it's the first phone with an inductive charging coil built in, allowing users to wirelessly charge the phone by just laying it on a charging-pad accessory.

# MICHELOB BREWING CO.





While electric mowers are cleaner, quieter and easier to maintain than their gas brethren, they rarely provide enough power to mow anything but a small lawn. The **Hustler Zeon (\$6500)** is the first electric zero-turn riding mower, and it's able to cut a bit over an acre on a single charge. Of course, many riding mower users deal with multiacre lawns, but this is a good start, and we wouldn't be surprised to see future models with longer-lasting batteries.



### Connected Camera

All Wi-Fi cameras allow users to upload files wirelessly, but the 10.1-megapixel, 4x-optical-zooming **Sony Cyber-shot DSC-G3 (\$500)** is the first that also has a built-in Web browser, allowing on-camera access to photo-sharing sites such as Picasa. In practice, uploading images was easy, but it took several minutes for larger photos—and there's no way to automatically shrink multi-megapixel photos to a Web-friendly size.

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*Bullrun host Bill Goldberg*

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# New Cars

KIA SOUL SPORT



Ford Fusion Hybrid  
Toyota Highlander  
Aprilia Shiver SL 750  
Ducati Monster 696

## City Slicker

One could argue that the Kia lineup—at least in the past—has been more like background scenery than iconography. That will likely change with the Soul, a hip new box poised to challenge Scion's xB. The Sport is powered by a 142-hp 2.0-liter inline Four paired to either a five-speed manual (our \$17,645 tester) or four-speed automatic. The motor is blessed with a broad torque spread that makes high engine speed largely unnecessary. You can cruise at 80-plus all day without undue fuel consumption—we averaged just north of 30 mpg. The Sport receives a real sport-tuned suspension and fat 18-in. wheels, so it can be hustled along at a surprising rate. There's an honest mechanical sense to the Soul, despite its somewhat inert steering and a slightly vague manual shifter. Yet, it all comes together in a car that is fun to drive—and to look at. —BARRY WINFIELD



++ **PM** TEST DRIVEN

+  
PM TEST  
DRIVEN  
+→ Kia Soul Sport | Ford Fusion Hybrid  
Aprilia Shiver SL 750 | Ducati Monster 696 X  
Toyota Highlander

## 1 2010 Ford Fusion Hybrid

## Home-Team Hybrid

Three years ago, when Ford began work on its \$27,995 Fusion Hybrid, few envisioned the ensuing fuel-price roller coaster. Luckily, Ford homed in on maximizing efficiency: The new Ford boasts an impressive rating of 41 mpg city and 36 mpg highway. The 191-hp hybrid powertrain can deliver over 700 miles on a tank, too. Use a gentle right foot and it really is possible to cruise close to the claimed 47-mph mark, gliding silently under electric power. It's a rather peaceful way to slice through traffic—until the gas engine kicks in. But drive more realistically and spool the engine all the way to redline every so often; economy will dip into the mid 30s. As always, the best way to achieve maximum fuel economy is with a delicate throttle. —BASEM WASEF

*Behind the wheel of the Fusion Hybrid, it's all about watching that SmartGauge screen. We used "Empower" mode, which offers info to assist in economical driving.*

*The 156-hp Atkinson-cycle Four requires less fuel on restarts, and the stop/start cycle occurs 1.5 times more often than on the Escape Hybrid—increasing efficiency.*

## 2 2009 Toyota Highlander

## Under the Radar

Hybrid powertrains may grab headlines, but sometimes efficiency doesn't require the added expense. For 2009, the Highlander is available with a new 187-hp 2.7-liter four-cylinder under the hood paired to a six-speed automatic. (The vehicle is only available in front-wheel-drive and base-trim levels.) It's rated at 20 mpg city and 27 mpg highway. After 400 miles we can report that this \$26,450 model doesn't relegate you to gas-hog status—or the slow lane. We averaged a solid 25 mpg during a combination of highway and city driving. That's within striking distance of the \$35,445, 27-mpg-city-, 25-mpg-highway-rated Hybrid. The powertrain offers reasonable pep, and the shifts are quick and nearly imperceptible—this is a smooth gearbox. Cruising along at 60 mph, we noticed the tach registered barely more than 1750 rpm. —B.W.



# Smart Innovative Design

Give your wheels the ultimate shine treatment. Introducing the **Black Magic™ Bullet**, a wheel polishing tool that's engineered to reach the closely spaced spokes of a wheel. The Bullet's smart, innovative design earned the product a Popular Mechanics Editor's Choice Award at the 2008 SEMA Show.



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BY THE AUTOMOTIVE EDITORS

**PM** EDITOR'S CHOICE AWARDS 08

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PM TEST  
DRIVEN

→ Kia Soul Sport | Ford Fusion Hybrid | Toyota Highlander |  
 Aprilia Shiver SL 750 | Ducati Monster 696 X

1



2



FIRST LOOK:

2010 **Honda Fury**

1 2009 Aprilia Shiver SL 750

2 2009 Ducati Monster 696

## Spine Tinger

Aprilia may barely register a blip on the collective radar of American riders. But for those who know, these bikes are the two-wheeled equivalent of a Lamborghini. Aprilia's most aggressive attempt yet at planting a stake in the U.S. market is its \$8999 Shiver, a 416-pound 750 cc naked bike that puts Ducati's iconic Monster squarely in its crosshairs. The Shiver's 95-hp V-twin provides plenty of thrust for enthusiastic riding, as well as a wonderfully raspy song. Power comes on strong and smooth from low rpm, and the lightweight feel makes it easy to lift the front wheel under moderately heavy throttle. We attacked the canyons of Southern California's Angeles Crest Highway and found the Shiver's hardware well-suited for aggressive riding. At low speeds or high, the Shiver feels agile and willing to change direction effortlessly. —B.W.

## Machismo Redefined

Sixteen years is a lifetime in the motorcycle world, but that's how long it took Ducati to redesign this icon. Hey, you can't afford to mess around with a megahit like the Monster. The air-cooled, 80-hp 696 cc L-twin engine is an exercise in simplicity. And the bike's compact proportions and 30.3-in. seat height make it welcoming to less-experienced riders. Throw a leg over the \$8995 Duc, and you lean forward. The position is more sporty than standard. The clutch feels light, as does the steering effort. But after a few hours in the saddle, the ride can get taxing. Though it's entertaining, the Monster 696 wouldn't be our first choice for a long-distance tour. Still, for brisk back-road fun, the Monster 696 is the right beast for the job. —B.W.

## HOT CHOPPER

In a shocking move, Honda has unveiled a production chopper. At first glance the bike boasts the usual chopper cues, but closer inspection reveals modern touches like liquid cooling and shaft drive. The fork is raked at a laid-back 38 degrees and the seat sits at a low 26.7 in. The 200 mm rear tire is just fat enough. And the Fury's tank looks like stretched taffy, leaving plenty of space above the cylinder heads, which cap the fuel-injected 1312 cc 52-degree V-twin. Honda promises an intoxicating exhaust note—for a chopper, that's a must. —B.W.

First Look | Honda Fury |



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The new **Black Magic™ Bullet Wheel Polishing Tool** is designed to polish your whole wheel – corners and all – in just minutes. Designed to attach to a variable-speed cordless drill, the Bullet wraps absorbent foam in gentle microfiber so you know only the softest, safest material is touching your rims. A flip-down handle adds control, so you can polish exactly where you want. The Black Magic™ Bullet Wheel Polishing Tool is a perfect accessory for getting the most brilliant shine out of your rims. For best results, use the Bullet with Black Magic's Titanium™ Wheel Polish.



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 AUTO  
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## DETROIT

Despite a shaky economy and a rougher-than-rough 2008 for automakers, the 2009 North American International Auto Show revealed sharp designs and innovation. But perhaps the biggest news came a week after the show itself, when Chrysler and Italian auto giant Fiat proposed an alliance. If finalized, Fiat will get a 35 percent share in Chrysler and access to American manufacturing. Chrysler will receive Fiat's hip, small cars. The move should give Chrysler the stamina to survive. Let's hope so. — **BEN STEWART**



**ON THE WEB** > Go to [popularmechanics.com/detroitautoshow09](http://popularmechanics.com/detroitautoshow09) for new reveals and analysis.

### 2010

#### Toyota Prius

↑ The all-new, third-generation Prius was the most anticipated reveal at Detroit. The new car hits the road this spring with a larger 1.8-liter engine and an improved hybrid-drive system. Thanks to careful aerodynamic tuning (a low .25 Cd) and reduced drivetrain weight, the new Prius is quicker than before (0 to 60 mph in a claimed 9.8 seconds), yet, according to Toyota, it will hit 50 mpg combined. Impressive. This new Prius has been designed from the beginning to be a plug-in hybrid. In place of the nickel-metal-hydride battery packs, Toyota will at some point within the next two years offer a plug-in version and install lithium-ion battery packs (now being developed with partner Panasonic). Exact timing for the plug-in is unknown, but Toyota will put 150 in fleet use by year's end.



5

## CARS THAT COULD SAVE DETROIT

1

## Concept Cadillac Converj

Think of this concept as the upscale version of the Chevy Volt. It uses the same extended-range plug-in technology. The Converj shows that GM could use the Volt's tech across several brands. And by expanding the volume of batteries and related systems, they'll lower cost—bringing the technology to more people.



2

## 2010 Ford Taurus

Ford's new Taurus is the most striking since the 1986 original. The platform and the 3.5-liter V6 are shared with the Lincoln MKS. Ford promises exemplary handling that will return the Taurus to its status as a driver's car. A hot-blooded SHO model is also coming this summer with all-wheel drive and 365 hp.



3

## 2010 Buick LaCrosse

Is this the best Buick sedan in decades? Could be. The specs and design look impressive. It's the first Buick sedan to offer all-wheel drive. And awd versions have real-time damping suspension and an electronic limited-slip rear differential. The top 280-hp 3.6-liter V6 model hits 26 mpg highway and 60 mph in 6.5 seconds.



4

## Concept Chrysler 200C EV

Here's an elegant, rear-drive sedan concept that uses a range-extended plug-in power like the Chevy Volt's. Chrysler says it can hit 60 mph in 7 seconds, drive for 40 miles on electric-only power and cruise for 400 miles without refueling. The 200C EV points to a future where we can enjoy large, roomy cars that sip fuel like much smaller ones.



5

## 2010 Lincoln MKT

In simple terms, the MKT is Lincoln's version of the Ford Flex. The MKT will be offered with two powertrains, a 3.7-liter 265-hp V6 and a twin-turbo version that should make 355 hp. Lincoln claims the MKT is quieter than the already hushed Flex. Practical three-row seating could make the MKT a cornerstone of the Lincoln lineup.







## Destination Super: **LAS VEGAS ROAD TRIP**

**F**lying to Las Vegas can strike a negative chord with tourists. Whether it's expensive plane tickets, ominous slot machines that beckon immediately upon arrival, or cab lines that cut a day short, there is always the chance of a vacation getting off on the wrong foot. Here's a viable alternative: how about packing up the family car and driving?

With a car at your disposal, you can put the casinos on tentative hold and take some truly memorable day trips. Starting with the **Valley of Fire**, a gorgeous state park about an hour Northeast of the strip. It's home to spectacular rock formations that every photographer will thoroughly enjoy. To the west, a 40-minute drive brings you directly to the picturesque **Red Rock Canyon**. It features a scenic loop, open daily from 6 AM through dusk, that should not be missed. And where to stay? Look no further than the Super 8 hotel located just 1 block off the strip at 4250 Koval Lane.

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## 3D'S BIG REVIVAL

> BY ERIN MCCARTHY

> ILLUSTRATION BY MAURIZIO SANTUCCI

**H**ollywood is buzzing about 3D. Dreamworks Animation CEO Jeffrey Katzenberg has compared it to the introduction of color. Director James Cameron delayed the release of his stereoscopic epic *Avatar* in part to give theaters more time to convert to 3D capability. A dozen or more stereoscopic films will be released in 2009, and more than 30 movies are in production. But stereoscopic films are not a revolutionary concept; in fact, audiences have been paying for them since *The Power of Love* in 1922. The golden age of 3D was in the 1950s, with a brief resurgence in the 1980s. Each time experts heralded the format as the next big thing in filmmaking, and each time, the surge quietly subsided.

So what has convinced Hollywood that 3D is

finally ready for its closeup? The short answer may be that technology has caught up with the concept. Stereoscopic films of the past were plagued by problems. "People always liked 3D," says David Cohen, an associate editor at *Variety*. "It just didn't work very well." The 3D format is now much more reliable, thanks to the introduction of digital technology and products developed by companies such as RealD, based in Beverly Hills, Calif.,

which spent 18 months combining stereoscopic science with digital projection. "NASA, the military

and Fortune 500 companies use 3D to design automobiles and aircraft, because you need to see the way we see in real life—with depth," says Michael Lewis, who before founding RealD created content for 3D IMAX films. "Our goal was to come up with a simple technology that would allow us to get that experience to the world.

3D HAS BEEN AROUND FOR A CENTURY. SO WHY IS EVERYONE EXCITED NOW?



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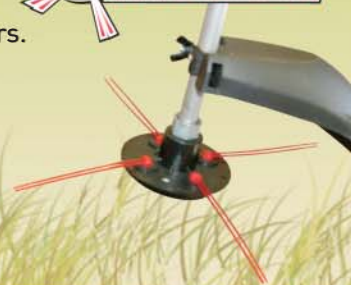
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Cinema, being at the top of the visual-food-chain experience, is where we felt we had to start."

## The 3D Headache

Humans naturally see in stereo because our eyes, set about 2 in. apart, each see a slightly different view; our brains combine that data into one image, which allows us to perceive depth. The 3D format tries to replicate this effect by shooting with two cameras, one representing each eye. But it's not as simple as setting the cameras eye-width apart and yelling "action." The distance between the two cameras, or inter-axial distance, determines the perceived depth of a scene, known as volume. "The wider you separate the cameras, the more 3D volume there is," says Phil McNally, global stereo effects supervisor at Dreamworks Animation. Shooting for a big screen and scaling down reduces 3D volume; shooting small and scaling up creates too much 3D, which is headache-inducing for viewers.

Filmmakers also need to calculate the zero parallax setting, or ZPS—the point where the two digital images converge onscreen. ZPS determines what appears to occur in front of the plane of the screen and what seems to happen behind the screen.

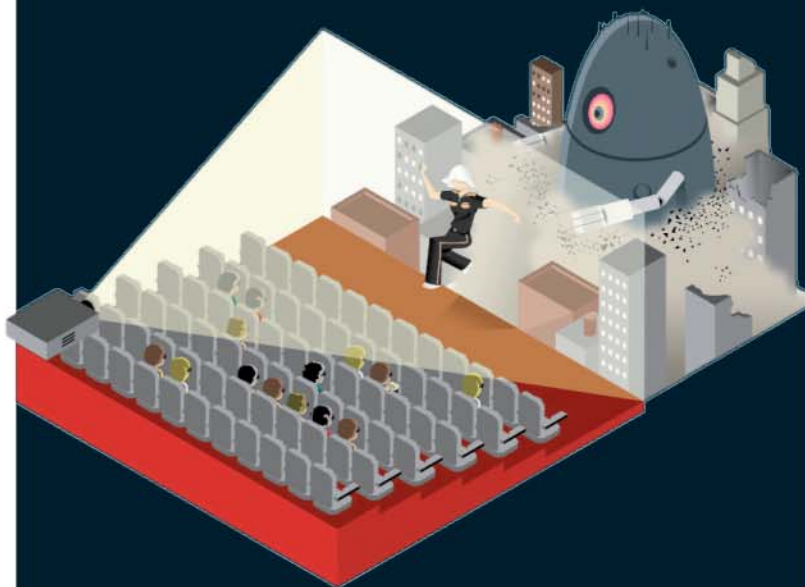
When 3D movies were shot on film, the potential for botched settings was huge because cameras had to be aligned by hand. But that was just the beginning of the problems with film. The cameras also had to capture a scene in perfect time with each other—which is impossible because even the movement of film through a camera causes distortion. In addition, the two rolls of film had to be matched precisely for color.

Projection in theaters was also problematic, since it was impossible to perfectly align the two projectors—again, one for each eye. Plus, film usually needs to be repaired during its life cycle, which created discrepancies between the two reels, resulting

## HOW IT WORKS

### 3D Animation

A stereoscopic movie consists of two slightly different views of the same action—one for each eye—which creates the illusion of depth. An audience wearing special glasses is able to see the heroine below jump into "personal space" (action that appears to occur in front of the screen), while the pursuing robot remains in "world space" (action that seems to take place behind the screen). Most studios plan to release upcoming animated films in 3D; here's how it's done.



#### Animation

Animators capture the action with stereo camera rigs they create in a computer. To ensure that no elements in a scene appear flat, filmmakers shoot with as many as three dual rigs. Commercial software and proprietary tools allow animators to precisely control what appears in personal space and world space,

and where the different camera views coincide.

#### Projection

A single digital projector, outfitted with a photo-optical device, superimposes the two films—each with a different polarization—on a special silver movie screen that is capable of showing both 3D and 2D films. The projector triple-flashes each

frame for each eye for a total of 144 frames per second—double the rate of regular cinema.

#### The View

Audience members wear glasses with circular polarization, which allows only one image into each eye by restricting light; the brain combines those images into 3D. The glasses also maintain stereoscopic fusion.

in films that were painful to watch.

As for the audience's role, filmmakers in the 1920s (and as recently as the 1980s) used overlapping red and cyan images—known as an anaglyph—to create stereoscopic movies. Audiences wore glasses with red and cyan lenses, which ensured that each eye saw only one of the two overlapping prints and allowed the brain to create a 3D image. Anaglyphs were originally designed for black and white, so using them on color film led to poor color representation.

During 3D's golden age, in the 1950s, stereoscopic movies relied on linear polarization and polarized glasses, which funneled images to the proper eye by restricting light. Polarization created better colors, but if viewers moved their heads, they disrupted the stereoscopic image.

## Digital Relief

Current 3D films, however, are subtle, immersive and easier to produce, thanks to digital technology. While some analog-era challenges still



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Elderly patients with dementia-related psychosis (eg, an inability to perform daily activities due to increased memory loss) taking ABILIFY have an increased risk of death or stroke. ABILIFY is not approved for treating these patients.

Some medicines can increase suicidal thoughts and behaviors in children, teens, and young adults. Serious mental illnesses are themselves associated with an increase in the risk of suicide. When taking ABILIFY call your doctor right away if you have new or worsening mood symptoms, unusual changes in behavior, or thoughts of suicide. Patients and their caregivers should be especially observant within the first few months of treatment or after a change in dose.

- Alert your doctor if you develop very high fever, rigid muscles, shaking, confusion, sweating, or increased heart rate and blood pressure, as these may be signs of a rare but potentially fatal condition called neuroleptic malignant syndrome (NMS)
- If you develop abnormal or uncontrollable facial movements, notify your doctor, as these may be signs of tardive dyskinesia (TD), which could become permanent
- If you have diabetes or have risk factors or symptoms of diabetes, your blood sugar should be monitored. High blood sugar has been reported with ABILIFY and medicines like it. In some cases, extreme high blood sugar can lead to coma or death
- Other risks may include lightheadedness upon standing, seizures, trouble swallowing, or impairment in judgment or motor skills. Until you know how ABILIFY affects you, you should not drive or operate machinery

The common side effects in adults in clinical trials ( $\geq 10\%$ ) include nausea, vomiting, constipation, headache, dizziness, an inner sense of restlessness or need to move (akathisia), anxiety and insomnia. Tell your doctor about all the medicines you're taking, since there are some risks for drug interactions. You should avoid alcohol while taking ABILIFY.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit [www.fda.gov/medwatch](http://www.fda.gov/medwatch), or call 1-800-FDA-1088.

Please read the Important Product Information about ABILIFY on the adjacent page.

**ABILIFY**<sup>®</sup>  
(aripiprazole)  
2, 5, 10, 15, 20, 30 mg Tablets

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## IMPORTANT INFORMATION ABOUT ABILIFY

This summary of the Package Insert contains risk and safety information for patients about ABILIFY. This summary does not include all information about ABILIFY and does not take the place of discussions with your healthcare professional about your treatment. Please read this important information before you start taking ABILIFY and discuss any questions about ABILIFY with your healthcare professional.

### Name

ABILIFY® (a-BIL-i-fi) (aripiprazole) (air-rī-PIP-ra-zoll)

### What is ABILIFY?

ABILIFY (aripiprazole) is a prescription medicine used for treatment of adult patients with manic or mixed episodes associated with Bipolar I Disorder.

### What is Bipolar I Disorder?

Bipolar I Disorder is an illness with symptoms thought to be caused by an imbalance of brain chemicals. People who have Bipolar I Disorder tend to experience extreme mood swings, along with other specific symptoms and behaviors. These mood swings, or "episodes," can take three forms: manic, depressive, or mixed episodes. Common symptoms of a manic episode are: feeling extremely happy, being very irritable and anxious, talking too fast and too much, and having more energy and needing less sleep than usual. Common symptoms of a depressive episode include: feelings of overwhelming sadness or emptiness, low energy, a loss of interest in things, trouble concentrating, changes in sleep or appetite, and thoughts of dying or suicide. A mixed episode includes symptoms that are both manic and depressive.

### Who should NOT take ABILIFY?

People who are allergic to ABILIFY or to any substance that is in it. Allergic reactions have ranged from rash, hives and itching to difficulty breathing and swelling of the face, lips, or tongue. Please talk with your healthcare professional.

### What is the most important information that I should know about ABILIFY?

Elderly patients, diagnosed with psychosis as a result of dementia (for example, an inability to perform daily activities as a result of increased memory loss), and who are treated with antipsychotic medicines including ABILIFY, are at an increased risk of death when compared to patients who are treated with a placebo (sugar pill). ABILIFY is not approved for the treatment of patients with dementia-related psychosis.

Some medicines can increase suicidal thoughts and behaviors in children, teens, and young adults. Serious mental illnesses are themselves associated with an increase in the risk of suicide. When taking ABILIFY call your doctor right away if you have new or worsening mood symptoms, unusual changes in behavior, or thoughts of suicide. Patients and their caregivers should be especially observant within the first few months of treatment or after a change in dose.

Serious side effects can occur with any antipsychotic medicine, including ABILIFY. Tell your healthcare professional right away if you have any conditions or side effects, including the following:

**Stroke or ministroke in elderly patients with dementia:** An increased risk of stroke and ministroke has been reported in clinical studies of elderly patients with dementia (for example, increased memory loss and inability to perform daily activities). ABILIFY is not approved for treating patients with dementia.

**Neuroleptic malignant syndrome (NMS):** Very high fever, rigid muscles, shaking, confusion, sweating, or increased heart rate and blood pressure may be signs of NMS, a rare but serious side effect that could be fatal.

**Tardive dyskinesia (TD):** Abnormal or uncontrollable movements of face, tongue, or other parts of body may be signs of a serious condition known as TD, which may be permanent.

**High blood sugar and diabetes:** Patients with diabetes and those having risk factors for diabetes (for example, obesity, family history of diabetes), as well as those with symptoms such as unexpected increases in thirst, urination, or hunger should have their blood sugar levels checked before and during treatment. Increases in blood sugar levels (hyperglycemia), in some cases serious and associated with coma or death, have been reported in patients taking ABILIFY, and medicines like it.

**Orthostatic hypotension:** Lightheadedness or faintness caused by a sudden change in heart rate and blood pressure when rising too quickly from a sitting or lying position (orthostatic hypotension) has been reported with ABILIFY.

**Suicidal thoughts:** If you have suicidal thoughts, you should tell your healthcare professional right away.

**Dysphagia:** Medicines like ABILIFY have been associated with swallowing problems (dysphagia). If you had or have swallowing problems, you should tell your healthcare professional.

### What should I talk to my healthcare provider about?

Patients and their families or caregivers should watch for new or worsening mood symptoms, unusual changes in behavior and thoughts of suicide, as well as for anxiety,

agitation, panic attacks, difficulty sleeping, irritability, hostility, aggressiveness, impulsivity, restlessness, or extreme hyperactivity. Call your healthcare provider right away if you have thoughts of suicide or if any of these symptoms are severe or occur suddenly. Be especially observant within the first few months of antidepressant treatment or whenever there is a change in dose.

### Tell your healthcare provider:

- About any medical conditions you may have
- Whether you're taking any other prescription or nonprescription (over-the-counter) medicines
- Whether you're pregnant, plan to become pregnant, or are breast-feeding
- If you or anyone in your family has had seizures
- If you or anyone in your family has had high blood sugar or diabetes

### What should I avoid when taking ABILIFY (aripiprazole)?

- Avoid overheating and dehydration
- Avoid driving or operating hazardous machinery until you know how ABILIFY affects you
- Avoid drinking alcohol
- Avoid breast-feeding an infant

### What are the possible side effects of ABILIFY?

Common side effects in adults include: nausea, vomiting, constipation, headache, dizziness, an inner sense of restlessness or need to move (akathisia), anxiety and insomnia.

It is important to contact your healthcare professional if you experience prolonged, abnormal muscle spasm or contraction which may be signs of a condition called dystonia.

### What percentage of people stopped taking ABILIFY due to side effects?

In clinical trials, the percentage of adults who discontinued taking ABILIFY due to side effects was ABILIFY (11%) and for patients treated with sugar pill (9%).

### Can I safely take ABILIFY while I'm taking other medications?

ABILIFY can be taken with most drugs; however, taking ABILIFY with some medicines may require your healthcare professional to adjust the dosage of ABILIFY.

Some medicines\* include:

- ketoconazole (NIZORAL®)
- quinidine (QUINIDEX®)
- fluoxetine (PROZAC®)
- paroxetine (PAXIL®)
- carbamazepine (TEGRETOL®)

It is important to tell your healthcare professional about all the medicines you're taking, just to be sure.

### General advice about ABILIFY:

- ABILIFY is usually taken once a day, with or without food
- ABILIFY should be kept out of the reach of children and pets
- Store ABILIFY Tablets and the Oral Solution at room temperature
- For patients who must limit their sugar intake, be aware that ABILIFY Oral Solution contains sugar
- For patients who cannot metabolize phenylalanine (those with phenylketonuria or PKU), ABILIFY DISCMLT® contains phenylalanine
- If you have additional questions, talk to your healthcare professional

### Find out more about ABILIFY:

Additional information can be found at [www.abilify.com/bipolardisorder](http://www.abilify.com/bipolardisorder)

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570U08CBS01902 0308L-1112 Printed in USA D6-B0001D-05-08-ABD May 2008



DIGITAL HOLLYWOOD ///  
3D REVIVAL

apply, filmmakers now use computers to determine interaxial distance and ZPS to align cameras. Digital capture eliminates issues with inconsistent film stock, and if a filmmaker still bungles the job, new software can be used to digitally correct errors in postproduction.

Whereas two film projectors were once required to show 3D, theaters can now use a single digital projector outfitted with a photo-optical device; theaters are in the process of replacing analog projectors with digital ones. (According to the Motion Picture Association of America, 4632 of the more than 40,000 movie screens in the United States had digital technology in 2007.) The film industry will save \$1.5 billion a year in print costs when it can send masters via satellite or fiberoptics, so it is partially underwriting the conversion: A digital projector and server cost a hefty \$70,000.

The ability to show 3D movies, says Perry Hoberman, an associate professor at the University of Southern California's film school, is a huge incentive for theaters. Not only does the experience give people a reason to leave their homes and HDTVs, but theaters can also charge more for tickets. (Katzenberg has proposed adding an extra \$5 to tickets for 3D



**Top:** An NFL Films cameraman captures last season's San Diego–Oakland game using a stereoscopic camera rig built by 3ality.



**Bottom:** James Cameron on the set of his 3D epic *Avatar*.

high-definition for the home is far away at all," the company's North American CEO and chairman Yoshi Yamada told reporters. In fact, a home-electronics group called the 3D@Home consortium estimates that 1.9 million 3D-ready TVs were sold in 2008. Panasonic is pushing an industry-wide standard for stereoscopic hi-def and has built a 3D Blu-ray disc-authoring center that aims to put stereoscopic

DVDs in stores by 2010.

The potential goes beyond DVDs: The NFL and NBA have beamed stereoscopic broadcasts of games into movie theaters. "It's not often that I get this excited about something," says Glenn Adamo, vice president of NFL Media Operations, who supervised the 3D broadcast of an Oakland Raiders–San Diego Chargers game in December. "I hope we get to do it again."

When it comes to movies, one thing seems certain: The chances of 3D sticking around are better this time. "It's not a huge bubble like in the 1950s, when everyone scrambled to produce 3D movies and didn't know what they were doing," Hoberman says. "The format works pretty well; there has been investment in various systems, and studios are making money on it. It's not going away this time."

PM

***"THE 3D FORMAT IS THE FIRST THING THAT'S A CARROT INSTEAD OF A STICK TO GET EXHIBITORS TO CONVERT TO DIGITAL," SAYS USC'S PERRY HOBERMAN.***

films.) "For exhibitors," Hoberman says, "it's the first thing to come along that's a carrot instead of a stick to get them to convert to digital."

Even polarized glasses have been upgraded. Today, filmmakers use circular polarization, which retains 3D fusion while allowing audience members to move their heads. "After 10 minutes, 3D used to be a bad experience," Lewis says. "With new technology, it's a really good one."

Box office from the first films in this latest stereoscopic era shows that audiences are hungry for 3D.

Disney/Pixar's *Bolt*, still in theaters at press time, earned approximately 41 percent of its \$111 million domestic box office from 3D, which accounted for 27 percent of the film's screens. *Journey to the Center of the Earth* earned approximately 60 percent of its \$102 million gross from 3D, which accounted for 30 percent of screens.

The home-electronics industry also wants to tap into 3D's popularity. At this year's Consumer Electronics Show, Samsung, Sony and Panasonic touted the format's home potential. "Panasonic does not think that 3D

# SOLAR RACER

> BY LARRY WEBSTER  
> PHOTOGRAPHS BY ZACH DESART

**T**

he car I'm sitting in is so futuristic and so technically advanced that it would cost nearly a million dollars to duplicate. Yet this Jet Propulsion Lab on wheels lacks the basic features of even the humblest sedan: a radio, roll-down windows, a heater. I had to slither between the rails of a roll cage to access a cockpit so cramped that it feels

as though I'm sitting upright in a Niagara Falls barrel.

This three-wheeled car, known as Continuum, isn't built for comfort—and it's not exactly built for speed. It's built for distance. More precisely, it's built to maximize the distance a featherlight electric car can travel in a given time powered solely by the amount of sunlight that

falls on photovoltaic cells plastered all over its upper half.

Working under the supervision of two faculty advisers, more than 100 very bright and very motivated University of Michigan students took two years to build the vehicle, which is designed to compete in a pair of grueling solar-car races. It's the latest model in a program that has racked up an impressive record since its 1990 inception: Five wins in the college-only 2400-mile North American Solar Challenge and several top finishes running against Honda, GM

LOOKS LIKE A UFO, STARTS LIKE A TURTLE, RUNS AS LONG AS THE SUN SHINES—DRIVING THE WOLVERINES' LATEST WINNER.

++ PM TEST DRIVEN

The University of Michigan's solar car, Continuum, glides around Chrysler's 4.7-mile oval.



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*Rock Islands in the Republic of Palau. Image ©Jez O'Hare*



CAR CULTURE///  
SOLAR RACER

and Ford in the 1870-mile Australia-based World Solar Challenge.

On this chilly and slightly overcast November morning, faculty adviser Ignacio Garcia, a retired engineering school machinist, and a dozen bleary-eyed team members trailered the car to Chrysler's Chelsea, Mich., proving grounds. Most team members have never driven Continuum, hence their nervous looks: I'm the first outsider ever to take a spin in a streamliner that cost them an awful lot of late nights and bloody knuckles. "We have a saying," says head strategist Alex Dowling, a 20-year-old junior from Saline, Mich. "You can have a social life, get good grades or do solar car. Pick two." A hardcore group of about 30 spends more than 30 hours per week on the project—designing, testing, fabricating and securing sponsorships for the \$2.4 million two-year budget.

I'm about 6 ft tall and weigh 180 pounds, which is 3 in. and 20 pounds too much for the cockpit. After an unsuccessful attempt with shoes on, I go socks-only and clear the small carbon-fiber steering wheel. My knees are practically kissing my chin. Luckily, the controls are on the steering wheel: A lever on the right works the "throttle," and one on the left activates the brakes. The team designed a dash that displays speed, charge state and distance traveled. They also built a rearview video-camera system and a wireless network that links the car to chase vehicles. The team remotely monitors Continuum with a Prius-like energy-flow graphic.

Once I'm buckled in, six students affix the upper part of the car's body in a series of moves so effortlessly choreographed it would make a Sprint Cup team jealous. The top half carries the solar array; the bottom half is the carbon-fiber and Nomex-honeycomb main structure.

As I gingerly pull back on the accelerator, the car inches forward at a turtle's pace. It's so pokey that a few team members walk alongside as I get underway. Weighing a lithe 480

➤ Continuum's rear aluminum wheels (top) were custom-machined with integrated hubs to reduce weight. The front wheel houses the electric motor. California-based Viper Technologies donated two sets of wheels worth more than \$40,000.

➔ Author begins the delicate entry procedure.

➔➔ Team members lower the top. The blue cloth in front of the driver is attached to the frame with hook-and-loop fasteners to keep road debris from entering the cockpit. It's a cheap, light, effective reminder that the best solution is often the simplest.







pounds, Continuum gets all the propulsion it needs from a 16-hp electric motor that resides in the single front wheel. The trike design lowers the car's surface area, which in turn reduces drag. How slippery is it? "It's a strategic advantage for other teams not to know," a cagey Dowling says. He reveals that the team believes a Corvette has five times as much drag as Continuum. But as I am about to learn, when it comes to handling, this is no Corvette.

With a single front wheel, I fear that any turn at speed will tip the car onto its outside edge, like a tricycle turned too hard by a reckless 3-year-old. "We talked to a vehicle dynamics professor when we designed the car," says John Federspiel, a 21-year-old junior from Rochester, Mich. "He had no idea about three-wheel dynamics. There's not much on the subject, so we had to figure it out ourselves." I creep up to about 30 mph and gently turn. The car responds more predictably and confidently than I could have imagined. I progressively wind in more steering angle until I feel the front end safely wash out in classic understeer. It's not fun, but it's stable and there is little body roll—these kids have done their homework.



CAR CULTURE///  
SOLAR RACER

While crisscrossing a vast expanse of proving-ground asphalt known as Black Lake, I buzz by the students at 40 mph. In 10 minutes, my hind-quarters have gone numb, but I'm in the groove and ready to head over to Chrysler's 4.7-mile banked oval so that I can open this baby up. I pull onto a pockmarked two-lane road and brace for the first impact. There's a loud thud, but the car isn't bothered by bumps. It feels solid and well-built. Because of the tight confines and lack of air, beads of sweat roll down my face despite the brisk weather. It's windy too, and I'm a little nervous about how crosswinds might affect a car shaped like a huge Delta wing. So when I get to the oval I stop and ask for a more experienced driver to try it first.

The team descends on the car. Jeff Rogers, a 22-year-old graduate student from Rochester Hills, Mich., shouts, "Waist!" and all six lift the top half about 1 ft. Someone unhooks two safety chains and disconnects the wires that connect the solar array to an electrical device called the maximum-power point-tracking system. The MPPT constantly changes the load on the solar array to extract maximum power. "Up!" Rogers barks. In another precisely timed maneuver, the team carries the top half away from the car and sets it down on sawhorses.

They're careful with the array since any scratch could reduce the efficiency of the 2726 solar cells. (Racing rules limit the area of the array to 6 square meters—about 7 square yards.) Each \$50 cell produces a maximum of 2.6 volts. In full sunlight, the array provides 2.4 hp, which is roughly what it takes to hold the car at 60 mph on a flat road—less than an eighth of the power a normal car requires.

I wiggle out, and Federspiel takes the helm. He moves out with two chase cars in tow. Dowling sits in the lead chase vehicle, staring at a laptop screen. "We monitor everything," he says. Obsessive Formula One engineers have nothing on these guys.



← The team designed the vehicle's wheels, brakes and hubs. The three-phase, in-wheel electric motor kit is built by Australia's national science agency.

↗ The solar array charges a \$17,000, 6-kwh, 66-pound lithium-polymer battery pack.

↓ Adviser Ignacio Garcia (third from left) with solar-car team members.

Federspiel drives a lap and gives the okay. I'm strapped back in. I floor it, the car rocks back slightly on its haunches, and we're off. The motor makes a loud growl until I clear 10 mph, and then all I hear are little pebbles zapping the bodywork. As speed slowly increases—51 mph, 52, 53—the car feels ever so slightly more eager.

The oval, with its perfectly smooth surface, is the same place Chrysler runs Chargers and Challengers flat out at supercar speeds, so at 60 mph, Continuum is, well, a bit underwhelming. It's hard to maintain that speed because the stiff winds dramatically slow the car whenever I let out the accelerator. Too bad I didn't learn to activate the car's cruise control. The real thrill here is, of course, knowing this car runs as long as the sun shines and the battery has juice—never stopping for a drop of petroleum or a charge from the power grid.

My legs are numb—again—so I prepare to stop. After I climb out, Dowling asks if other team members would like a turn. I can sense their excitement. I wander over to faculty

adviser Ignacio Garcia. "So, these kids really built this thing?" I ask.

"Yes. I only step in if there's a safety issue or if they ask," Garcia says. "The adults are there for support. It's amazing what the students have done."

In addition to engineering know-how, these students run the program like a Fortune 500 tech company. It's split into four divisions, and team members have weekly progress meetings, workflow charts, a Web-based forum to catalog every move, even custom stationery. They solicit design advice from solar-car alumni and invite companies to teach them carbon-fiber construction.

Several students who have taken their first spin are giddy from the experience. Someone suggests that 6-ft 3-in., 210-pound Chris Hammond, a 21-year-old junior from Clarkston, Mich., give it a go. He makes it halfway into the cockpit before he gets stuck and yells for help. It's the outcome everyone knew was coming. But they laugh and chide him in a way only a fraternity full of brothers could. They are, after all, still college students.

PM



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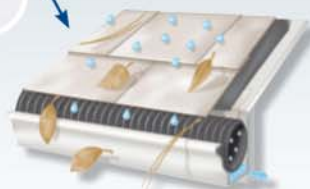
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# SAFETY THROUGH DANGER?

> BY GLENN HARLAN REYNOLDS  
> ILLUSTRATION BY JOHN HENDRIX

WHEN DRIVERS GET TOO COMFORTABLE, ADVANCES IN SAFETY START TO LOOK LIKE RETREATS.

**R**eadings Tom Vanderbilt's latest book, *Traffic: Why We Drive the Way We Do (and What It Says About Us)*, I was struck by a recurring theme: Making things safer may actually make them more dangerous. I wonder if it's a lesson that also applies off the road.

Vanderbilt describes driving along a narrow, twisting road in Spain, where he navigated hairpin turns with few guardrails or warning signs over steep drop-offs. The result: "I drove as if my life depended on it." But when he reached a four-lane highway with gentle curves, good visibility and little traffic, "I just about fell asleep and ran off the road ... Lulled by safety, I'd acted more dangerously."

There is a fair amount of scientific evidence that backs up Vanderbilt's insights. Give people antilock brakes, airbags and other safety devices, and they "consume" the safety improvements by driving more aggressively. This phenomenon is called the Peltzman

Effect, after economist Sam Peltzman, who first wrote about it in 1976. The decades-long effort to make highways straighter, wider and better-marked, with more guardrails and rumble strips, has eliminated one class of dangers only to foster another: the complacent driver with a cellphone in one hand and a cup of coffee in the other, steering the vehicle with a knee while occasionally glancing at what's ahead.

Meanwhile, modifying roads and intersections so drivers are less comfortable—by making driving, in some ways, more dangerous—forces people to slow down and pay attention, producing a change in behavior that, paradoxically, results in more safety. This is also true for pedestrians, who Vanderbilt says are more cautious away from crosswalks than within them because they don't know if cars will actually stop.

Likewise, traffic circles and squares, which demand a driver's full attention, turn out to be both safer and better at handling large volumes of traffic than traditional four-way intersections with traffic lights. In the former, people focus on what's going on; in the latter, they relax and expect







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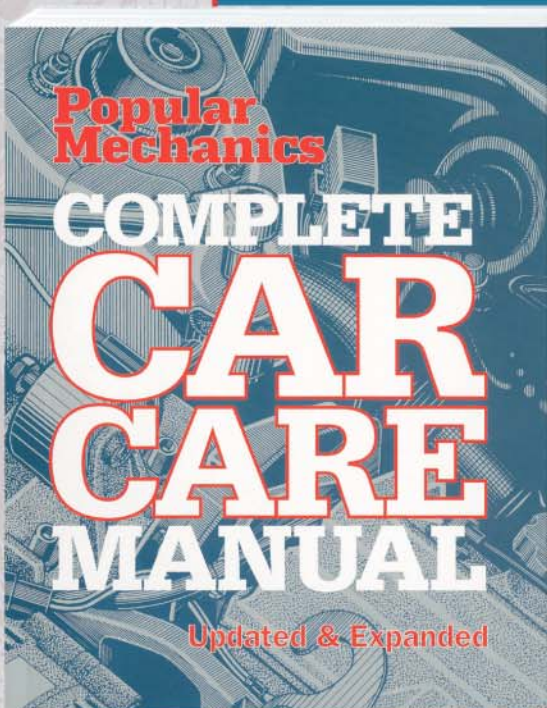
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# THINKING AHEAD /// TRAFFIC SAFETY

the traffic signals to do all the work. Drivers in traffic circles also communicate more with hand signals and eye contact. As Vanderbilt notes, when a traditional four-way intersection with lights was turned into a traffic square, “The responsibility for getting through the intersection was now up to the users, and they responded by communicating among themselves. The result was that the system was safer, even

## TRAFFIC CIRCLES, WHICH DEMAND A DRIVER’S FULL ATTENTION, TURN OUT TO BE SAFER THAN FOUR-WAY INTERSECTIONS WITH TRAFFIC LIGHTS.

though the majority of users, polled in local surveys, felt that the system was more dangerous!”

Vanderbilt also says that change causes people to pay more attention, and hence drive more safely. In 1967, when Sweden switched from driving on the left to driving on the right, many people predicted that accidents would increase. But accident rates dropped noticeably, and took a year to return to the pre-changeover level. The change, and the fear of accidents it produced, caused people to drive more carefully. The lesson here is that familiarity breeds slackness, and regular challenges encourage mindfulness and attention. Instead of designing roads and devices to accommodate people who are dozing through life, we might produce better performance by designing things with an eye toward engaging attention.

Famed Dutch traffic engineer Hans Monderman once said: “When you treat people like idiots, they’ll behave like that.” Monderman’s philosophy is, instead, to design things so that people are called on to use their wits—at least within limits. When that happens, things often wind up safer.

I’m not ready to plow up all the interstates and replace them with cow paths, but this approach does

ring true. In our modern world, lots of things compete for our attention, and where we can take things for granted, we’re likely to do so, even if it’s not really a good idea.

The safety-through-danger approach extends to cars. Modern cars are quiet, powerful and capable of astonishing grip in curves, even on wet pavement. That’s swell, of course, until you suddenly lose traction at 75 mph. The sense of confidence bred by all this capability makes us feel safe, which causes us to drive faster than we probably should. We don’t want to make cars



Like all traffic circles, this interchange in Bavaria requires motorists to slow down and focus on safe driving strategies.

with poor response, but perhaps we could design cues—steering-wheel vibration devices, as in video games?—that make us feel less safe at speed and encourage more care. Designers could make cars feel faster at lower speeds, instead of slower at higher speeds. Done right, this might even make driving more fun. In college I drove an Austin-Healey 3000 that somehow felt faster at 45 mph than my Mazda RX-8 (or even my Toyota Highlander Hybrid) feels at 75 mph. That was a good thing.

This approach could be taken beyond the world of personal transportation. We’re in the current financial mess in part because things that were actually dangerous—from

subprime mortgages to risky financial instruments that no one fully understood—felt safe and ordinary. Modern financial markets, with computers, regulations, deposit insurance and bond ratings, felt as routine and as smooth as that four-lane highway in Spain, causing a lot of people who should have been paying attention to doze off. Investors might have been more careful if it had felt like they were driving down a twisty mountain road with no guardrails, especially since we really *were* engaged in the financial equivalent of high-speed mountain driving, only without the discipline of fear.

In athletics, protection sometimes leads to more risk-taking. Research has shown that skiers who wear helmets ski faster than those who do not. Likewise, firearms instructors are quick to stress that the safety on a gun doesn’t actually render the weapon safe, just marginally safer, so that all usual precautions still apply. And I noticed when scuba diving with a spare air cylinder that instructors were concerned these backups would become popular with inexperienced divers and that this reliance might breed carelessness with the main equipment.

The traffic example demonstrates a general phenomenon of modern society: With the best of intentions, we tend to replace situations that call on the use of our wits with situations that we can sleepwalk through, and the solutions to matters with any serious consequences are postponed to the indefinite future. That’s a comfortable way to live, and there are good reasons to be glad of it—we’re not in a situation where one bad harvest means starvation, after all—but if you can postpone problems indefinitely, a lot of problems will be postponed. Yet the future eventually arrives. As Vanderbilt observes, “The pursuit of a kind of absolute safety, above all other considerations,” can make things less safe. For designers, lawmakers and the rest of us, it’s worth keeping this in mind. Complacency and comfort have their place, but they also have their perils, as we are learning. **PM**





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#### SmartShedding<sup>®</sup> Technology

Allows the master outlet to sense when your computer has either been turned off or has gone into sleep mode, so it can shut off power to peripherals plugged into the controlled outlets—saving you power and money.

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Uses up to 5x less power in normal operation than any other battery backup.

#### Let's protect what's important.

What's in your computer? Photos, music, personal files, financial data, broadband access, videos, and more. Your computer has never been more important, and yet it has never been at higher risk for damaging power surges and other disturbances.

So like most people, you need to protect your assets. But like most people, you'd also like to protect the environment. With our new energy conscious products, you can do both. Energy efficient by design, our new smart products protect the power going into your computer, at a cost that is quickly offset by big energy savings. How? Not only do the new Back-UPS ES<sup>®</sup> and SurgeArrest<sup>®</sup> use power very wisely, they also boast a master/controlled outlets feature, which automatically powers down idle devices to conserve energy.

APC power protection products are available at:



that was easy.

PC Connection

*"The price tag on the new UPS is \$99. While I'm not in the habit of endorsing products in this blog, if you're in the market for a workstation-class UPS, why not opt for the greener option?"*

- Heather Clancy,  
ZDNet.com

In fact, while protecting your power supply, we're up to 5 times more energy efficient than any other solution. By saving you \$40 a year in energy costs, our Back-UPS ES pays for itself in 2 short years. The high frequency, low copper design has a smaller transformer and environmental footprint. Even the packaging has been carefully selected and manufactured to maximize use of recycled materials and minimize waste.

In this world, every decision you make counts. So protect your power with a battery backup that works to protect the environment. It conserves power, it pays for itself, and it's backed by APC's 20-plus years of Legendary Reliability<sup>®</sup>. For more information on this or our other great products, or for information about environmentally responsible disposal of your old battery, visit [www.apc.com](http://www.apc.com)



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Guaranteed protection from surges, spikes, and lightning.

7 outlets, Phone/Fax/Modem Protection, Master/Controlled Outlets



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Our most energy efficient backup for home computers.

10 outlets, DSL and Coax protection, Master/Controlled Outlets, High Frequency Design, 70 minutes of runtime<sup>†</sup>

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APC can help with your other power protection needs. Visit [apc.com](http://apc.com) to see our complete line of innovative products.

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e-mail: [esupport@apc.com](mailto:esupport@apc.com) • 132 Fairgrounds Road, West Kingston, RI 02892 USA • 998-0967 <sup>†</sup>Runtimes may vary depending on load.

\*Average savings are based on comparable competitive models, and are comprised of two energy saving features: an ultra efficient electrical design, and the master/controlled outlets feature.









# THE SMARTER HOME 2009

WHEN IT COMES  
TO CONSERVING  
RESOURCES,  
EVERY BUILDING  
CAN DO BETTER.  
HERE, PM'S  
GUIDE TO  
PRODUCTS AND  
PROJECTS THAT  
CAN HELP  
UNLOCK YOUR  
HOUSE'S HIDDEN  
POTENTIAL.



*by*

**Elizabeth  
Svoboda**

*photograph by*

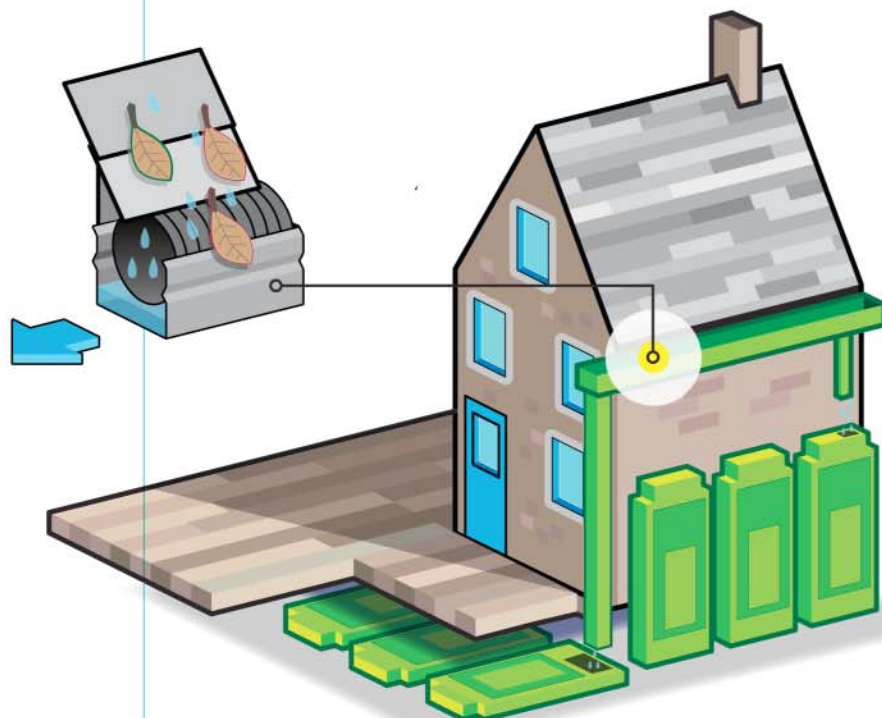
**Fredrik  
Brodén**



## **Step into any home-improvement store**

these days and you'll confront a smorgasbord of "eco-friendly" labels crafted to grab your attention: VOC-Free! Saves Energy! All Natural! It's easy to take a cynical attitude toward this profusion of promises. As "green" has gone mainstream, it's become tough to tell the true contenders from the impostors who slap on seductive stickers.

We've sifted through hundreds of products to bring you the best—innovations that lighten your home's impact on the planet in a measurable, meaningful way. Our favorites range from modest (an under-the-drain device that conserves shower heat) to mammoth (an entire home built from recycled shipping containers). The engineers behind these products and systems consider their work's impact from development to disposal—no spin can substitute for design that simply makes sense.



### RAINWATER HOG, RAINTUBE Water- Collection System

■ Collecting rainwater for gardening conserves supplies and controls runoff—but most people don't want a hulking tank out back. Australian architect Sally Dominguez says manufacturers "basically laughed" at her search for a svelte cistern—so she designed her own. Each 6-ft-tall Rainwater Hog stores up to 51 gal, yet only occupies 1.3 sq ft of yard. Its modular shape allows it to slide under the deck, squeeze against a side wall or sit side by side for greater capacity. Use the Hog with the RainTube gutter filter to clean water of debris before it enters the receptacle.

### INTEGRITY BLOCK

## Building Better Concrete

■ Manufacturing the cement that binds typical concrete causes about 5 percent of global CO<sub>2</sub> emissions. Integrity Block, which makes a structurally sound concrete replacement, shaves that figure by using 40 percent less cement in its rammed-earth masonry. Up to half of each block is composed of quarry scraps. "Quarries are typically after a particular mineral," says Shawn Cunningham, the company's vice-president of marketing. "Everything else gets poured out." As for looks: "When you stack them against a concrete equivalent, there's no comparison," Cunningham says. After using these red Sedona landscape blocks, we tend to agree.



### AGILEWAVES Home- Efficiency Monitor

■ Conservation upgrades save energy and water—the challenge is deciphering just how much. Agilewaves' Web-based Resource Monitor tracks a home's utility usage in real time, then calculates how much CO<sub>2</sub> it generates. While other monitors chart water, gas and electricity, Agilewaves' can include solar and geothermal systems in its snapshot. It also incorporates energy prices to show how much money a homeowner is spending—and where the biggest savings are.

### ECODRAIN Shower Heat Exchanger

■ You already paid to heat the water washing down your shower drain—why waste it? EcoDrain's heat exchanger transfers heat from water passing through the shower drain to fresh cold water headed to the tap (the two don't mix). A typical shower consumes 12 gal of hot water; the EcoDrain reduces the energy your water heater uses for that purpose by 25 to 40 percent.



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**BIG ASS FANS**

## Moving Massive Amounts of Air



■ When it comes to heating and cooling large rooms efficiently, bigger fans are better. Most regular-ass fans top out at just under 5 ft in diameter, but the blades on a Big Ass Fan range from 6 to 24 ft. The size and design let them turn slowly—using less energy—while still achieving 25 times the airflow of models you might find in a warehouse. Also, typical fans rely on gears that buzz audibly and reduce efficiency; Big Ass models operate silently and smoothly courtesy of a series of magnetic pads, which power the blades' friction-free rotation. Unwelcome noise prompted this Knoxville, Tenn., homeowner to replace his industrial clunker with a Big Ass Element model, which uses only a  $\frac{3}{4}$ -hp motor to spin its 12-ft blades.





## ***POWER TO FINISH EVERY JOB RIGHT***

Whether you're filling gaps and cracks to insulate, air-seal or simply keep pests out of homes, there's not a more permanent, energy-saving solution than GREAT STUFF™ Insulating Foam Sealant. In fact, a job completed without it probably isn't complete at all. Learn more about our complete line of building products at [dowGREATSTUFF.com](http://dowGREATSTUFF.com).





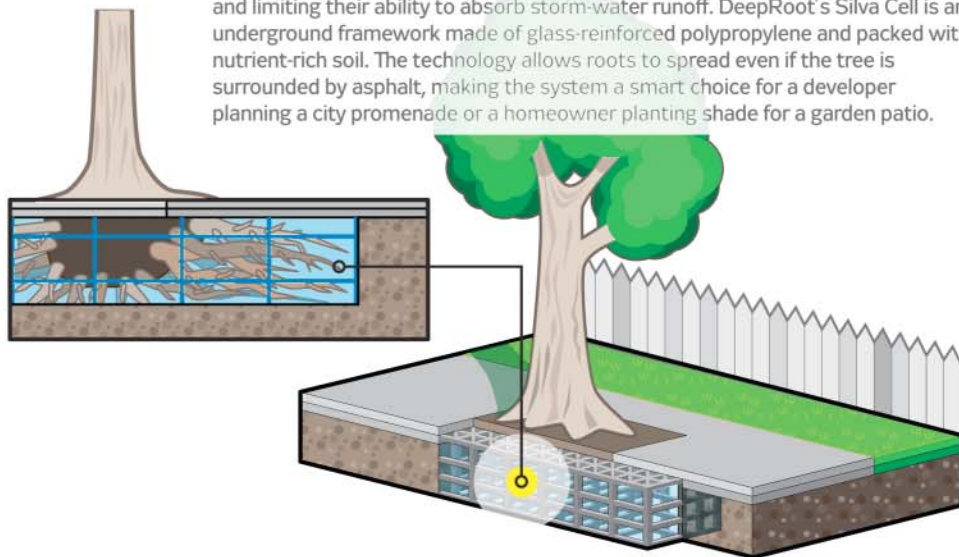
### NATUREMILL Easy Indoor Compost

■ Compost keeps food waste out of landfills while enriching garden topsoil—but producing it at home can be a dirty job. NatureMill's under-the-counter composter makes the whole process as easy as tossing scraps into the kitchen disposal. "I was composting in my own yard, and I liked the benefits, but I couldn't stand the smell," says Russ Cohn, NatureMill's founder and CEO. As waste is mixed, heated and aerated in NatureMill's upper chamber, a charcoal air filter neutralizes odors. Decomposed waste then drops to a lower chamber, providing fresh loads of compost every two weeks. The entire process consumes 5 kilowatt-hours a month—about as much as a typical night light.

### DEEPROOT SILVA CELL

## Safer Sidewalks, Healthier Trees

■ The roots of trees can push sidewalks out of position, and the gravel-heavy aggregate that supports traffic above them compacts soil, stifling root growth and limiting their ability to absorb storm-water runoff. DeepRoot's Silva Cell is an underground framework made of glass-reinforced polypropylene and packed with nutrient-rich soil. The technology allows roots to spread even if the tree is surrounded by asphalt, making the system a smart choice for a developer planning a city promenade or a homeowner planting shade for a garden patio.



### SG BLOCKS


## Shipping-Container Housing



■ Former merchant officer David Cross got plenty of exposure to shipping containers in the four years he spent cruising the world on cargo vessels. Cross saw the large corrugated-steel boxes reused as tool sheds in China, then later, as communications shelters for the military—but he always thought their "highest use" would be in housing. Thus began Safe, Green (SG) Blocks, where Cross now works as business development director. "We take instruments of trade and turn them into instruments of construction," Cross says. They do it by cutting open several of the 40-ft long, 8-ft wide, nearly 10-ft-tall blocks and combining them to form frames for anything from simple Colonials to the chic, modern Harbinger House (left). Converting the boxes takes 95 percent less energy than scrapping and extracting the usable metal; Cross calls the adaptive process recycling on steroids. Factor in the solar panels, rainwater recycling and sustainable flooring options, and SG Blocks save much more than steel boxes.



# 30 DAYS of green



Cosmopolitan  
Country Living  
The Daily Green  
Esquire  
Good Housekeeping  
Harper's Bazaar  
House Beautiful  
Marie Claire  
O, The Oprah Magazine  
Popular Mechanics  
Redbook  
Seventeen  
SmartMoney  
Town&Country  
Veranda

## Can you change the world in 30 days?

You absolutely can get started, by making greener, smarter choices in your everyday life.

Give previously owned items a new life to make our world cleaner and healthier. Look for energy-saving items and products made from sustainable or recycled materials. Look for ways to reduce your carbon footprint by combining shopping trips, or shop online with ground shipping. 30 Days of Green provides thousands of simple ideas like these that you can incorporate every day—embracing just one can make a difference and be the beginning of a sustainable lifestyle that lasts a lifetime.

Hearst Magazines, in our own operations and practices, has made significant commitments to protect the environment. Together with our partner eBay, a pioneer in sustainable commerce, we're celebrating the efforts you can make every day, too.



Discover inspiring, eco-friendly shopping tips and ENTER FOR A CHANCE TO WIN a \$5,000 shopping experience or one of thousands of other great prizes at [www.eBay.com/greenteam](http://www.eBay.com/greenteam)



# 10 WAYS TO RAISE YOUR HOUSE'S IQ THIS YEAR ...

These weekend projects will conserve energy, water and, ultimately, your hard-earned cash. With today's technology, you can be conscientious *and* comfortable.

## Kitchen

### Find sustainable finishes. ■

Kitchen upgrades offer a chance to choose products made from recycled or renewable materials. Consider a stone countertop made with recycled glass, a sustainable cork or natural linoleum floor, or cabinetry made from formaldehyde-free plywood.

## Living Room

### Build better fires. ■

To boost efficiency in the fireplace, begin by replacing the leakprone mid-chimney "throat" damper with a "top-sealing" or "chimney cap" damper. This opens, shuts and seals like a storm door for the chimney. Then add a fire-back—a handsome iron plate that protects firebox brick and radiates heat into the room. A fireplace heater will distribute the fire's warmth by circulating air into the fireplace. A heat exchanger warms the air and fans blow it (smoke-free) back into the room, increasing the fireplace's efficiency from 5 to 65 percent. If you don't use your fireplace at all, contact the National Chimney Sweep Guild to find a certified contractor to seal your flue, which will prevent heat loss through the chimney.

### Upgrade the thermostat. ■

Nearly half of the average home's \$2000 annual energy bill goes toward heating and cooling, but a programmable thermostat can reduce that figure by about \$180. Instead of a seven-day model, opt for a five-plus-two-day one—this will allow you to program the temperature for different weekday and weekend schedules, maximizing comfort and efficiency.

### Go chemical-free. ■

Caustic chemicals will partially dissolve a clog, but they contaminate water supplies, and the fix won't last. Instead, turn to the sink plunger—its flat bottom sits flush with the sink, unlike a bell-shaped toilet plunger. Before snaking a drain or removing the sink's trap, try using needle-nose pliers or creatively bent coat hangers.

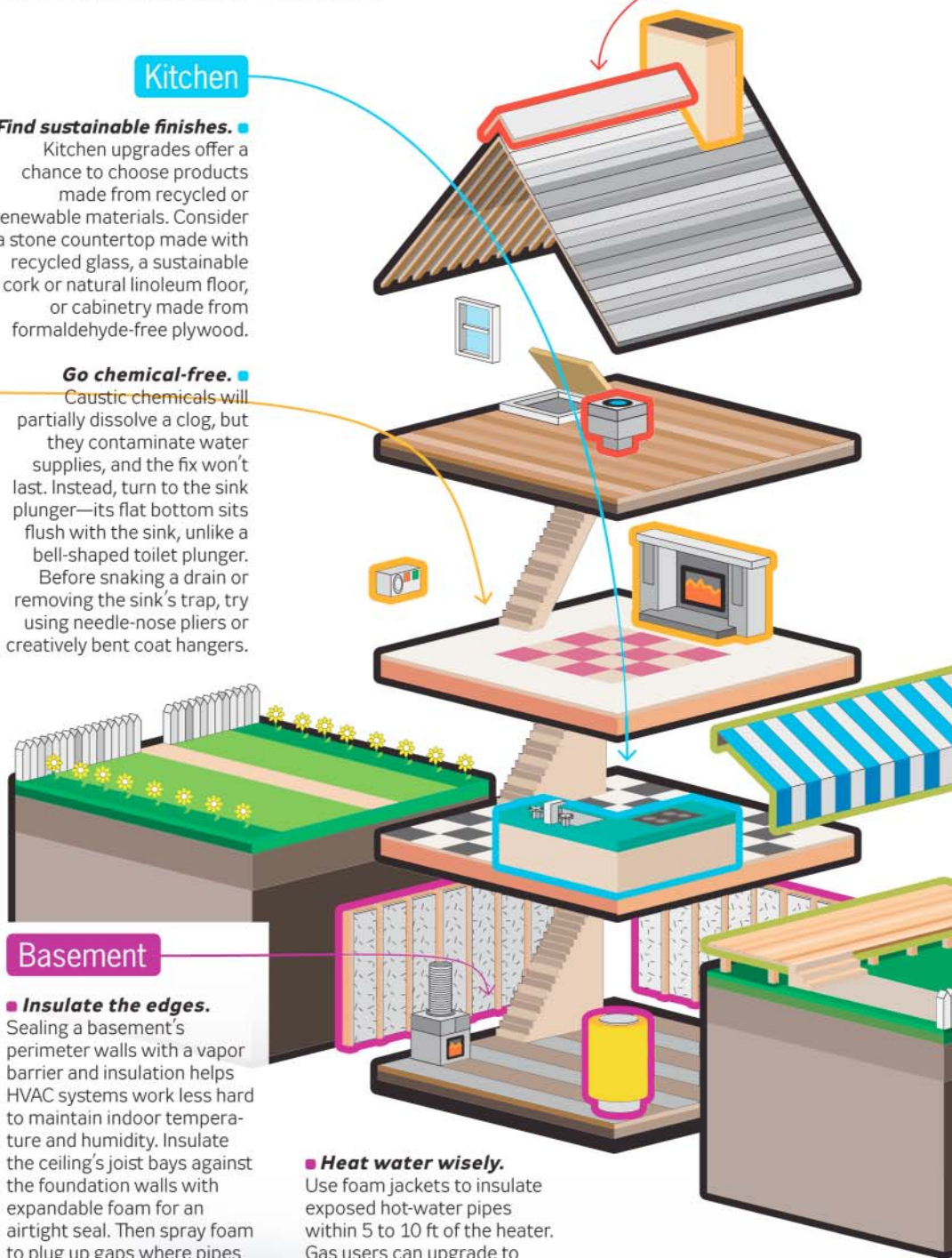
## Basement

### Insulate the edges. ■

Sealing a basement's perimeter walls with a vapor barrier and insulation helps HVAC systems work less hard to maintain indoor temperature and humidity. Insulate the ceiling's joist bays against the foundation walls with expandable foam for an airtight seal. Then spray foam to plug up gaps where pipes and vents exit the house.

### Heat water wisely. ■

Use foam jackets to insulate exposed hot-water pipes within 5 to 10 ft of the heater. Gas users can upgrade to fuel-saving tankless heaters; electric users should add timers so water stays hot only when it's needed.





## Attic

### ■ **Ventilate the space.**

Install inconspicuous ridge vents that run the length of the attic's peak. These work with soffit vents to cool the attic in summer; in winter, an exit route for warm air reduces the risk of leak-causing ice dams.

### ■ **Cut a/c consumption.**

Whole-house fans pull in outside air through the downstairs windows and push out hot air through the attic vents, cooling your house at a fraction of the cost of central a/c. Effective except on the most stifling summer days, the typical whole-house fan consumes less than 600 watts, but a 5-ton central air unit can draw more than 6000. Solar-powered attic fans are very efficient too, but ventilate only the attic space, not the living area.

## Yard

### ■ **Make decks last decades.**

Composite decking built with recycled plastic uses waste headed for a landfill. Redwood, cedar and ipe naturally resist rot and can last much longer than pressure-treated wood. But buy only lumber certified "Pure" by the Forest Stewardship Council—there are no bad species, just bad forestry.

### ■ **Add an awning.**

Decks reflect the sun's rays into your house, but adding shade above nearby windows and glass doors can reduce heat intake by up to 77 percent. In the summer, a retractable awning cuts an adjacent room's a/c use by nearly 25 percent. It rolls out of the way in the winter to allow warm sunlight in.

# GREEN

## Eco-shopping's secret



By Cat Schwartz,  
*eBay Gadget & Toy Director*

**EBAY GADGET AND TOY DIRECTOR CAT SCHWARTZ** has been reporting on gadgets and technology for 10 years.

### **CREDO Tread™ Phone Case**

This phone case made from recycled tires is a great cover for your refurbished cell phone.



## WITH TECHNOLOGY ADVANCING SO QUICKLY, THERE ARE TERRIFIC DEALS TO BE HAD ON LAST SEASON'S ELECTRONICS.

Today, gadget-loving buyers and sellers have made eBay the hottest marketplace to help keep wallets full and landfills empty. It's even a great place to find smart, energy-saving tools (who knew a backpack could convert sunlight into electricity?).

And because I buy about 20% of my gadgets refurbished—which helps reduce the carbon footprint of new manufacturing—I don't feel so guilty about indulging my love of electronics.



### **Stainless Steel Watch**

Secondhand watches offer great savings AND save on new raw materials.

### **New-to-You Designer Belt**

New-to-you styles offer great savings AND reduce the need for new manufacturing.



## Eco-shop (and shape) the world:

- When searching eBay, use terms such as "last season," "refurbished," "pre-owned" or "used" for great deals on first-generation iPhones, HDTVs and digital cameras.
- eBay is also a one-stop-shop for new, ultracool eco-friendly gadgets like solar-powered phone chargers, hybrid (energy-efficient) PCs and recycled-rubber electronics cases.
- With the money you save, consider making a microfinance investment. At [www.microplace.com](http://www.microplace.com), you can earn a financial return while helping someone work their way out of poverty. It's good for you, and good for the world.

[www.eBay.com/greenteam](http://www.eBay.com/greenteam)

### **Toshiba Cinema Series™ TV**

Flat LCD TVs offer beauty, clarity and energy savings.



# YOUR LIFE:

## condhand surge



### Vintage Rock T-Shirt

Reduce unnecessary use of dyes and show style that sets you apart.

### Did you know?

The sale of used laptops on eBay last year saved over 69,000 tons of CO<sub>2</sub>—equal to saving 437 acres of trees.

### Solio™ Solar Mobile Device Charger

Use energy straight from the sun to power up your smart phone or MP3 player.



### Voltaic™ Solar Bag

Save energy. Power your laptop with one day of direct sunlight.



eBay®



## ... AND 14 STEPS TO TAKE TODAY

Stroll through your home with PM's list of low-cost (or free!) upgrades, making quick fixes as you go.

□

### TURN DOWN THE WATER HEATER

Lower the temperature to 120 F, and for every 10-degree drop, you recoup 3 to 5 percent of the power bill. No temperature dial on the tank? Check the temp at the tap farthest from the heater.

□

### UNPLUG APPLIANCES

Turn off power strips or pull the plug on appliances completely. Idle machines suck up 11 percent of your home's electricity.

□

### CLEAN YOUR DRYER

Slip a shop-vacuum hose into the dryer's guts to remove lint wads and boost efficiency. Use an electric leaf blower to clear lint from vents that lead to the outside. It'll work like new.

□

### OPTIMIZE HEATING AND COOLING

Move furniture and rugs away from vents and radiators. Run a fan with the a/c raised 2 degrees to drop cooling costs by 14 percent.

□

### DRIP-IRRIGATE BEDS

Line gardens with hoses—no sprinklers, no hassle. Use mulch to retain moisture, and set timers to water in the morning.

□

### ADJUST MOWER BLADES

Cut no more than one-third the grass blades' length—this helps them to develop strong roots, remain moist and absorb runoff.

□

### TRUST THE DISHWASHER

Fully loaded, the dishwasher uses less water than hand-washing dishes. Save power by using the air-dry mode, not heat.

□

### INSULATE THE ATTIC HATCH

Keep the conditioned air downstairs by weatherstripping the attic hatch's edges. Cover the hatch with rigid polystyrene insulation.

□

### USE SMALL APPLIANCES

Downsize your cooking device: Toaster ovens consume half the energy of a full-size electric oven; microwaves use only one-third.

□

### INSTALL STORM WINDOWS

Storm windows reduce heat loss through windows by 25 to 50 percent. Magnetic internal storm windows go up without a ladder.

□

### STREAMLINE THE FRIDGE

Fridges work best at about 38 F; freezers should register between 0 F and 5 F. Leave a thermometer inside for 24 hours, then check it.

□

### KEEP FILTERS CLEAN

Pleated electrostatic filters catch up to 60 percent of allergens (blue fiberglass ones only catch lint and dust). Change them every two to three months or as soon as they show discoloration.

□

### DRAW THE CURTAINS

Cover windows to prevent air loss. Curtains engineered for insulation multiply the R-value of standard insulated glass.

□

### FIX A LEAKY TOILET

Drop food coloring in the tank; if it ends up in the bowl, there's a leak. Replacing the flapper can save thousands of gallons of water a year.



# With eBay, you always save something (LIKE THE PLANET).

**Did you know?**  
eBay Inc. is doing its part, too. It has the largest commercial solar panel installation in the city of San Jose, CA, and has been a carbon-neutral company since 2007.

A big part of our impact comes from the buying decisions we make every day. eBay's great deals have always helped you green your life—one shopping decision at a time. How? eBay consumers have "re-used" an estimated \$100 billion in goods since 1998. And buying pre-owned products is just one of the many ways to make greener, smarter choices with eBay and practice "conscious consumption."



VINTAGE ADVANTAGE



SUSTAINABLE STYLE



NEW ENERGY

## THE VINTAGE ADVANTAGE.

When you give a used product a new life by buying it on eBay, you reduce the emissions associated with manufacturing and decrease the need for new raw materials.

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You can tap into the trend toward eco-friendly choices by looking for items that are made from recycled, organic or other sustainable materials.

## BUY WITH A NEW ENERGY.

Discover unique items like solar-powered phone chargers, hybrid (energy-efficient) computers, and other items that will help you use less energy and create less waste.

Win one of eight **\$5,000**  
"Green Your Life"  
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## Join eBay's Green Team



## BE EVEN MORE OF A HERO FOR THE PLANET.

Visit [eBay.com/greenteam](http://eBay.com/greenteam) to discover inspiring, eco-friendly shopping tips and learn how your shopping decisions can have a greater positive impact than you might imagine.

**Enter the sweepstakes** for a chance to win one of thousands of prizes—like this eBay Green Team water bottle—that will help you begin a sustainable lifestyle.

**Together, the 85 million people who use eBay can be a powerful collective force for the planet.**





## ELEMENT FOUR WATERMILL

## Water From Air

■ British Columbia-based Element Four helps ease water shortages by pulling moisture straight out of the air. Engineered for muggy outdoor environments or humid indoor rooms, the wall-mountable WaterMill constantly adjusts to the ambient dew point. Fans pull in air, then the water vapor within condenses as it flows across metal coils. The condensation passes through a carbon filter, and ultraviolet light sterilizes it. Each WaterMill can produce up to 12 liters of potable water per day.



## Reinventing the Tree

■ As organizations such as the Forest Stewardship Council (FSC) set the rules for safe harvesting, engineers are hard at work redefining the nature of lumber itself. These three wood alternatives represent a creative approach to a classic material.

## ENGINEERED TIMBER RESOURCES FLOORING FROM SALVAGED WOOD

When companies mill furniture and paper, they create a waste stream of seemingly unusable wood. Engineered Timber Resources presses these postindustrial byproducts into new decking, flooring, furniture and panels. Its flagship product, Songwood, combines the scraps of seven types of FSC-certified hardwood from the floors of Chinese mills, resulting in a beautifully striated grain.



## OSMOSE MICROPRO BETTER PRESSURE-TREATED LUMBER

Pressure-treated lumber resists rot, fungus and insect damage, thanks to copper pressed into the boards. But most manufacturers dissolve the copper particles, creating a liquid preservative that leaches out and corrodes aluminum flashing. Osmose grinds the copper particles instead, so they penetrate into the wood in solid form. This means less leaching, no corrosion and lumber that shows a paint or stain's true color rather than pressure-treated wood's telltale green hue.



## NYLOBOARD CARPET-SCRAP COMPOSITE PANELS

An estimated 5 billion pounds of used carpet enters U.S. landfills each year. Nyloboard collects these unwanted scraps, then melts them down into panels for use as structural sheathing. The product has advantages over typical oriented-strand board or plywood. "The boards are impervious to moisture, so there's no cupping, warping or splitting as they acclimate," says Danny DeVito, Nyloboard's director of marketing. "There are no insects, rotting, mold or mildew, either."



PM  
COVER  
STORY  
///  
**CYBER ATTACK**

# WEAPON

## OF MASS DISRUPTION

THE NEXT WORLD WAR might not start with a bang, but with a blackout. An enemy could send a few lines of code to control computers at key power plants, causing equipment to overheat and melt down, plunging sectors of the U.S. and Canadian grid into darkness. Trains could roll to a stop on their tracks, while airport landing lights

Hackers could use the very computer systems that keep America's infrastructure running to bring down key utilities and industries. Just how worried should we be?

BY GLENN DERENE

wink out and the few traffic lights that remain active blink at random.

In the silence and darkness, citizens may panic, or they may just sit tight and wait for it all to reboot. Either way, much of the country would be blind and unresponsive to outside events. And that might be the enemy's objective: Divert America's attention while mounting an offensive against another country.

Pentagon planners have long understood the danger of cyber attacks on U.S. military networks. Indeed, the Defense Department's Global Information Grid is one of the most frequently targeted computer networks on Earth. But the cat-and-mouse game of information espionage on military networks is not the only digital threat that keeps national-security experts up at night. There is a growing concern over the vulnerability of far more tangible assets essential to the economy and well-being of American citizens.

Much of the critical infrastructure





that keeps the country humming—water-treatment facilities, refineries, pipelines, dams, the electrical grid—is operated using a hodgepodge of technologies known as industrial control systems. Like banks and telecommunications networks, which are also generally considered critical infrastructure, these industrial facilities and utilities are owned by private companies that are responsible for maintaining their own security.

But many of the control systems in the industrial world were installed years ago with few or no cyber-security features. That wasn't a big problem when these systems were self-contained. But in the past two decades, many of these controls have been patched into company computer networks, which are themselves linked to the Internet. And when it comes to computer security, a good rule of thumb is that any device that is computer-controlled and networked is vulnerable to hacking.

Bad-guy hackers pulling the plug on public utilities is a common theme of Hollywood films, including 2007's *Live Free or Die Hard*, but such scenarios present more than a mere fictional scare to U.S. intelligence officials. According to Melissa Hathaway, cyber-coordination executive for the Office of the Director of National Intelligence, the list of potential adversaries in a cyber attack is long, ranging from disgruntled employees to criminals to hostile nations.

Most experts agree that China and Russia routinely probe our industrial networks, looking for information and vulnerabilities to use as leverage in any potential dispute. James Lewis, a cyber-security expert for the policy think tank Center for Strategic and International Studies (CSIS), says that although cyber warfare couldn't cripple the U.S., it could serve as an effective military tactic. "If I were China, and I were going to invade Taiwan," he says, "and I needed to complete the conquest in seven days, then it's an attractive option to turn off all the electricity, screw up the banks and so on." Could the entire U.S. grid be taken

## Digital Sabotage

Much of America's infrastructure is computer-controlled and therefore subject to hacking. Below: A status check of five key sectors. Opposite: An in-depth look at the vulnerabilities of a natural gas pipeline.

Transportation	Finance	Telecom	Water
● Railroads, shipyards, airports and city traffic systems all rely on centralized computer networks to run smoothly. Last year two Los Angeles traffic engineers pled guilty to accessing the Automated Traffic Surveillance Center and shutting down four traffic lights to influence a union dispute.	● Modern banking is entirely reliant on digital money transfer and computer databases. In January, a tech contractor was indicted for planting a digital "logic bomb" on mortgage giant Fannie Mae's servers. The malicious code was designed to destroy all data on the company's network.	● The bad news is that telecommunications connects everything, and vulnerabilities are manifest. The good news is that the sprawling system is hard to knock out of commission because of redundant connections across widely distributed fiberoptic lines and backbone computers.	● It may not be the first target most people think about, but the outdated computer-control systems that regulate the flow of water and wastewater could make easy targets for hackers. In 2006, computers at a Harrisburg, Pa., water-filtering plant were hijacked for the distribution of spam e-mail.

down in such an attack? "The honest answer is that we don't know," Lewis says. "And I don't like that answer."

### GHOSTS IN THE MACHINE

IN JANUARY 2008, SENIOR CIA analyst Tom Donahue dropped a bombshell on a small conference of government officials and power-company engineers from the U.S. and Europe. He told them that extortionists had managed to hack into utilities in mul-

multiple regions outside the United States and disrupt power equipment. "In at least one case," he said, "the disruption caused a power outage affecting multiple cities." The CIA has been highly secretive about the incident, and Donahue would not discuss where the blackouts occurred or what companies were affected. But he admitted that the CIA had no idea who had perpetrated the attacks. Hackers had shaken down a public utility, it seems, and had gotten away with it.

MODEL BY MEGAN CAPONETTO (OPENER)



## Energy

America's oil and gas pipelines and electrical grid depend on an awkward marriage of antiquated control-system hardware and modern information technology. The infrastructure itself is spread over vast distances and owned by multiple companies. Here are five cyber-security holes in the nation's energy network—and ways to fix them.

### FLASH-DRIVE DROP

**Where: Parking Lot** Human nature can sometimes provide an easy end run around a strong firewall. An old hacker trick is to drop a USB drive in a public area, then count on the curiosity of passersby to do the rest. When a facility employee plugs the USB drive into his work computer to identify the owner of the device, the drive automatically installs hidden rootkit software that invites the bad guys in.

**Protection:** It may sound mundane, but a good deal of cyber security is awareness and education. Hackers are con artists as well as

computer scientists, so employees of infrastructure facilities should be taught not to fall for social-engineering tricks.

### INSIDE MAN

**Where: Control Station** The most dangerous threat to any facility's computer system is someone who understands its inner workings. A disgruntled computer tech can install hardware, such as a DSL modem, that enables him to access and control the refinery's network remotely.

**Protection:** Split up network maintenance between multiple employees. Keep a detailed

inventory of all equipment connected to industrial control systems.

Some security professionals think that government officials have been guilty of as much drama-mongering on the issue as Hollywood has. "Honestly, I think the threat is overblown," says Bruce Schneier, author of *Schneier on Security*. "The risks today are due more to errors than to malicious intent." He sees Donahue's story as nothing more than a tenebrous rumor. Nevertheless, Schneier thinks vulnerabilities in infrastructure will eventually become a real national-security threat.

The problem is that the errors that Schneier refers to can cause bad things to happen. Much of computer hacking is predicated on exploiting glitches in commonly used systems. Such exploits on a Windows PC are irritating, but at a nuclear facility, they can be unnerving.

In August 2006, a glitch shut down the Browns Ferry nuclear power plant in northern Alabama. Plant administrators lost control of recirculation pumps on one of the plant's reactors because of excessive data traffic on the control-

system network. The plant was forced to go offline temporarily.

Nuclear plants are designed to shut down in the event of major malfunctions to prevent a Chernobyl-style catastrophe. But they also generate almost 20 percent of U.S. power. What if a hacker exploited a coding error in a cooling system to shut down a sizable piece of the nation's power supply?

Incidents of digital malfunctions that cause danger to human life are rare, but such events have happened. In June 1999, in Bellingham, Wash., shortly before a routine delivery of gasoline by the Olympic Pipe Line Co., a worker updated a database for the



## INTERNET ATTACK

**Where: Remote Location** Attackers have a variety of options for breaking into an industrial facility's operations: Often, control systems are connected to corporate systems, so commonly known Windows or server vulnerabilities can open a back door into the control room. Some equipment may be so old that it is accessible by dial-up modem. Hackers can search for vulnerable equipment by using a "war-dialer" program that automatically calls through a list of phone numbers looking for modems.

**Protection:** Experts advocate placing firewalls between corporate networks and control systems and installing access-control software on old equipment.

Compressor Station



## BREAK-IN

**Where: Compressor Station** Pipelines and other sprawling infrastructure systems have many remote, unmanned substations. Entry is often a matter of cutting a fence and jacking into the controls with a laptop. Many facilities have wireless access points that could allow attackers to log in from a distance—no bolt cutters required.

**Protection:** Cyber security often means physical security, such as taller fences and tougher locks.

Plus, wireless access for critical control systems should be password-protected.

## CASCADE EFFECT

**Where: Power Plant** An attack on one utility can cripple downstream facilities. For example, nearly half the electrical power in California is generated using natural gas. A cyber attack on compressor stations that fuel electrical power plants could result in multistate blackouts.

**Protection:** Upcoming Smart Grid tech will add intelligence to control systems, automatically rerouting power during a crisis.

Electrical Power Plant

company's pipeline computer-control system. According to a report by the National Transportation Safety Board, a simple typo in the database caused the system to fail, disabling remote control for the pipeline's operators, 98 miles away in Renton, Wash. Pressure began to build in the line, so the operator issued a command to open a secondary pump to relieve it, but the system was unresponsive. A weak point in the pipeline ruptured, releasing 237,000 gal of gasoline into nearby Whatcom Creek.

An hour and a half later, the gasoline ignited. The ensuing fireball scorched more than a mile of riverbank, killing three people, including two 10-year-old boys, and damaged the city's water-treatment facility.

## THE AURORA VULNERABILITY

**CONVENTIONAL WISDOM** about digital attacks is that you can steal information, and you may even be able to shut down critical systems, but

any damage would be temporary and superficial. A cyber attacker could generate a lot of confusion by killing the lights in California, but give the state and utility officials a few days to reset the systems, and everything would be back up and running. It's a phenomenon that infrastructure security expert Eric Byres, of Byres Security, refers to as "weapons of mass annoyance."

In 2007, however, a video leaked out of the Department of Homeland Security that showed an experiment the



DHS had sponsored at Idaho National Laboratory. In the video, a massive, green diesel generator shakes violently and belches smoke as it goes into total meltdown. Dubbed the Aurora experiment, it demonstrated how an over-the-Internet cyber attack could cripple big, essential machines.

When the video hit CNN, it alarmed many in the utilities industry. Most of the details of the Aurora vulnerability have not been released, but DHS statements about the experimental hack describe it as a man-in-the-middle, or spoofing, attack, in which a malicious computer intercepts all traffic going between two other computers, essentially controlling the line of communication between them. According to Sean McGurk, director of control systems security for the DHS, the vulnerability was common to control systems throughout critical infrastructure.

## THE SABOTEUR'S STORY

**THE MOST FREQUENTLY TOLD** anecdote in the world of infrastructure cyber security is that of Maroochy Shire. The incident, which occurred in Queensland, Australia, is viewed by many in the industry as an object lesson in the damage that can be done when someone with computer skills and a grudge takes aim at a public system. In 2000, Vitek Boden, a computer expert in his late 40s who had been turned down for a job in municipal government, rigged up his laptop computer to a radio-frequency wireless transceiver to hack into the city's computerized wastewater

management system. Over the course of two months, Boden broke into the system 46 times, instructing it to spill hundreds of thousands of gallons of raw sewage into rivers, parks and public areas.

He was finally caught when a police officer pulled him over and found control-systems equipment in his car.

The reason the Maroochy Shire incident is recounted so frequently is that it shows how difficult it is to thwart hackers who want to disrupt the infrastructure, since attacks can come from almost anywhere. An insider with detailed knowledge could target a specific company's system, or a hacker could launch an anonymous Internet assault from a distant country.

The Department of Homeland Security's Computer Emergency Readiness Team (known as US-CERT) encourages industry to report cyber accidents and intrusions, but there are few legal requirements for private companies to do so. It is possible that many more incidents have occurred, and companies have simply kept them quiet.

Infrastructure is meant to last a long time, so upgrades to existing systems tend to occur at a glacial pace. "There is a long life cycle associated with this," says Jeff Dagle, chief electrical engineer at the Department of Energy's Northwest National Labs. "Utilities are used to this equipment lasting 30 years." Nevertheless, big utilities and industrial facilities are starting to see cyber security as a reliability issue, and are modernizing

their equipment, building redundant, multitiered networks (a tactic known in military circles as "defense in depth"). The caveat is that with big utility networks such as the electrical grid, telecommunications or pipelines, a clever adversary wouldn't attack the well-defended components of the system. "Why should I go after the company that put a lot of money into securing its networks when I can get into one that hasn't and damage them both?" asks the CSIS's James Lewis.

Ironically, the current weakness of the economy may provide a shot in the arm for the digital defenses of critical infrastructure. Much of President Obama's stimulus package is aimed at revitalizing infrastructure, and as antiquated equipment gets upgraded, modern security technology can be built in. One example is the Smart Grid, a Department of Energy plan that could receive around \$4.5 billion to modernize the nation's electricity delivery system with state-of-the-art computer controls. Of course, more computing technology in the grid allows for more potential attacks, but it could also mean a more robust and nimble defense.

The result may be infrastructure networks that are a lot like the Internet itself. The redundancy and flexibility of the Internet's core architecture has allowed it to withstand two massive denial-of-service attacks—in 2002 and 2007—on the 13 Domain Name System root servers that make up the backbone of the system. In each instance, the servers absorbed incredible amounts of traffic as parts of the system either failed or came close to failing. To the engineers who run the system, it was terrifying, but the rest of the world barely noticed. If our infrastructure were that robust, the cyber war of the future might have little more impact on your life than a dimming of the lights and a shrug of your shoulders. **PM**

CAN THE GRID BE TAKEN DOWN IN A CYBER ATTACK? SECURITY EXPERT JAMES LEWIS SAYS: **"THE ANSWER IS THAT WE DON'T KNOW. AND I DON'T LIKE THAT ANSWER."**





Tethered to a helicopter, a Coast Guard swimmer enrolled at the rescue school in Astoria, Ore., drops into the Pacific. Opposite: The Coasties' classroom—big swells at the mouth of the Columbia River.





## / **MASTERS OF RESCUE**

/ *At America's elite helicopter rescue academy, Coast Guard professionals are put to the test by ocean cliffs, sea caves and a treacherous stretch of coastline known as the Graveyard of the Pacific. PM attends a challenging course at the school of disaster heroes.*

/ *By KALEE THOMPSON*

/ **I HEAR THE HELICOPTER BEFORE I SEE IT.** A gentle whirl at first, the noise grows to chain-saw strength as the orange-and-white-striped pod hurtles into view and settles into a hover over a paved landing pad just a couple of hundred yards from the Pacific Ocean. Standing in the tall grass at the edge of the clearing, I brace myself against the rotor wash. One foot back, knees bent, head down. Even in my bulky flight suit and visored helmet, the wind whips through me. If I stood up straight, the blast would knock me down.

In seconds, the aircraft—a 65-ft-long HH-60 Jayhawk—has settled gently onto the blacktop. The side door slides open, and the flight mechanic jumps out. At his thumbs up, I run toward the open cab of the helicopter. The space inside is no bigger than the interior of an SUV and stacked with safety equipment: A rescue



basket and harnesses used for pulling victims from the water, emergency survival suits and a life raft for the crew. I hook my helmet into the aircraft's internal communication system (ICS)—the noise inside is far too loud to hear anyone without it—and buckle myself into the jumpseat. I practice releasing the buckle a few times to be sure I'll be able to get out quickly if necessary. I've been told that you can survive a helicopter crash in water if you hang on tight to something inside the aircraft. Let go, and you become disoriented. The windows have pull tabs that allow you to push them out in an emergency. As I'm studying them, we rise from the field with a barely noticeable shudder and swoop out toward the open ocean.

I've come to the Pacific Northwest in late autumn to attend the Coast Guard's Advanced Helicopter Rescue School in Astoria, Ore. Members of the armed forces have long been trained to deploy from aircraft to save downed comrades, and occasionally those skills have been applied to civilian rescue. The Coast Guard, however, didn't have a program in place until the mid-1980s to allow a specially trained rescuer to leave the helicopter. By the early 1990s, every helicopter-

The Coast Guard's HH-60 Jayhawk is the workhorse of big-water rescue. A variant of the Army's Black Hawk, the Sikorsky aircraft has a range of more than 300 miles.



equipped Coast Guard air station had rescue swimmers on staff, saving dozens of lives a year. A steady supply of new rescue situations, though, highlighted the need for more specialized training, and ultimately helped prompt the creation of the advanced school in 1995.

The one-week course is held eight times a year in the churning swells that form where the Columbia River meets the Pacific at the border of Oregon and Washington state—an area known as the Graveyard of the Pacific for the 2000 shipwrecks strewn across the ocean floor. The course is timed to take advantage of the most hazardous conditions this region can rile up. Today the classroom will be an area known as the Middle Grounds, near Cape Disappointment, Washington.

In the Jayhawk with me are two Coast Guard pilots stationed on Cape Cod, two Coast Guard rescue swimmers (one has come from Michigan, the other from Puerto Rico), a young flight mechanic named David Bowers and school instructor Brian Daniels. This week's 16 students are already full-time

professional rescuers. Most are Coasties, though two spots in each class are reserved for Air Force parajumpers or Navy rescue swimmers, who line up for the chance to train at the country's most intensive helicopter rescue school. In all, half of the students have passed the grueling physical and mental tests that earn them the right to jump out of aircraft for a living. The other half are helicopter pilots and flight mechanics. They've all practiced countless airlifts before, and most have helped to save lives in real rescues. This training presents challenges, though, that many have not encountered: bigger waves, colder water, caves, cliffs and unpredictable ocean currents.

**IT TAKES ONLY MINUTES** to reach the training site. One of the pilots spots sea lions, and I strain to see them out the window. We're not much more than half a mile from shore, but the water is shallow: Every few minutes a 15-ft wave breaks, spreading a wall of froth over the ocean.

By the time the pilots pull into a hover, rescue swimmers Michael von Bormann and Stephen Gonzalez are geared up in yellow rescue helmets, fins, masks and snorkels. They'll take turns playing victim and rescuer today. Gonzalez—the victim—goes down first. "Swimmer ready," Bowers announces through the ICS as Gonzalez sits with his legs out the open cabin door, his black fins pointing down toward the waves below. Over his orange dry suit, Gonzalez wears a harness that's clipped into a hook on the end of the helicopter's external hoist. "Direct deployment of rescue swimmer to surf from 50 ft," Bowers says, retracting the hoist cable and easing Gonzalez out the door.

Below us, rotor wash creates a perfect white disk of foamy spray. Gonzalez, spinning slowly as he descends, looks like he's about to hit the bull's-eye. The swimmer circles a forearm to the side of his body—the sign for "down." Now detached from the ICS, Gonzalez must rely on precise hand signals that the flight mechanic can "read" from his kneeling position at the edge of the open aircraft door. Bowers, in turn, feeds the pilots a constant stream of information: "Swimmer going down. Swimmer halfway down. Swimmer at the water."

Being immersed in these waves can feel like being in a gigantic washing machine. The 100-mph winds whipped up by the rotors make matters worse. And so, today the crews are practicing rescues using a catenary procedure. The swimmer remains attached to the hoist while the flight mechanic pays out enough cable—the stretch is called the catenary—to allow the bird to move to the side of the rescue scene, sparing victim and rescuer dangerous rotor wash.

The maneuver requires constant, precise communication between flight mechanic and pilots—and I listen in on all of



*The men must synchronize the length of cable with the position of the helicopter. Too much line, and the rescue swimmer and victim in the water could become tangled in the excess. Too little, and they could be sent “waterskiing.”*

it through the ICS. The men must synchronize the catenary length with the position of the helicopter. Too much line, and the rescue swimmer and victim in the water could become tangled in the excess, with deadly results. Too little, and they could be sent “waterskiing”—pulled violently along the surface like a skipping stone.

When he reaches the water, Gonzalez detaches from the hoist cable, which Bowers raises back to the helo. The process is repeated with von Bormann, who will attempt to rescue Gonzalez. Once the two men are in the water, though, the waves pick up. Soon, Gonzalez and von Bormann are buried under a breaking swell more than 20 ft high.

It’s only a couple of seconds until they pop up, but from my vantage 50 ft up in the helicopter it seems much longer. “Took them a long time to surface on that one, didn’t it?” Daniels says, just moments before another wave breaks over the two tiny yellow dots—all that’s visible of Gonzalez and von Bormann. “Yeah, I didn’t see them for a little bit,” Bowers replies. It’s the mechanic’s job to keep the people in the water in sight, but in these conditions, that’s nearly impossible. Another wave pummels the swimmers. “Alrighty, it’s getting to be pretty sporty,” one of the pilots announces.

The conditions seem harrowing, but the mood in the aircraft is calm. It takes only a couple of minutes before both swimmers are safely back inside, the only casualty a lost snorkel. Before I ever got in the helicopter I understood the intensive preparation all these men go through to do their jobs. On the first day of the class, I watched Gonzalez, von Bormann and the other swimmers easily pass a timed physical-fitness test comprising sit-ups and push-ups—50 of each—as well as chin-ups, pull-ups and underwater sprints in a local pool. The pilots fly weekly training missions and regularly practice emergency procedures in a simulator. From the back of the helicopter, though, it becomes clear that pulling off the rescues these men could face at any time demands more than individual physical or technical skill. It requires the ability to make decisions quickly and collaboratively. It requires each member of the four-person crew to remain focused and calm and to communicate clearly in the midst of chaos.

“They’re exposed to extreme situations,” says Senior Chief Clay Hill, the head of the school and himself a Coast Guard rescue swimmer. “We’re giving them the experience—and the confidence—to face these conditions.” Once they’ve dealt with harrowing scenarios in training, such as a high-seas rescue, dealing with the same circumstances during a real emergency becomes almost automatic, Hill explains. By the end of a typical five-day course, the students have studied classroom theory and have put theory to the test. They have lifted a victim from rough seas using a rescue basket as well as a harness

system. The swimmers have completed drills in caves. They have struggled out from the beach through a half-mile of breaking surf and dangerous riptides. All the students, swimmers as well as flight crews, have been left to float on the open ocean, zipped up in tiny, tent-

like, one-man life rafts, simulating the experience of people they may someday be sent to rescue—individuals who may be too sick, too cold or just too scared to help themselves.

**IT’S THE LAST DAY OF CLASS**, and Gonzalez is again sitting at the open doorway of the helicopter, this time above a coastal cliff. Below the helicopter, a plastic dummy affectionately known as SpongeBob hangs precariously from the rock. Gonzalez’s job: Rescue the mannequin without detaching himself from the hoist. As Gonzalez is lowered, Bowers again feeds the rest of the crew critical information: “Swimmer going down. Swimmer halfway down.”



Rescue swimmer Stephen Gonzalez plucked this mannequin from a coastal cliff—all part of the training at the Coast Guard’s Advanced Helicopter Rescue School.

Gonzalez finds his footing on the cliff. From the helicopter, the training exercise looks far more dangerous—and impressive—than the water rescue. It’s breezy, and we’re only a few dozen feet from unforgiving rock, yet the hover is perfectly still. I’m apparently not the only one who’s impressed: A crowd has gathered on a beach adjacent to the cliff.

As the swimmer maneuvers toward the mannequin, Bowers feeds the pilots commands to keep the hoist line plumb. If there’s too much of an angle between the belly of the helicopter and the swimmer, he’ll swing like a pendulum when he loses contact with the cliff. “Right 10, right five,” Bowers says. “Easy right and hold, hold.” Keeping his weight on the hoist line, Gonzalez shuffles downslope until he’s just beneath SpongeBob. Within a few minutes of exiting the helicopter, he has the dummy in a harness that attaches to his own and is ready to be pulled back up. Secured in a gunner’s belt at the open cabin door, I’ve watched the crowd on the beach grow. It’s too far away to tell if anyone is clapping, but as Gonzalez slides into the helicopter with SpongeBob, I know I want to. “Swimmer and victim are in the cabin,” Bowers announces. And with that, the Jayhawk backs smoothly away from the cliff and swoops up over the rugged Pacific coastline.

**PM**

- WRITER: Ben Stewart
- PHOTOGRAPHER: Jeff Minton

## • **THE FAST AND THE FRUGAL**

- *The best way to grin through roller-coaster fuel prices and a down economy is to choose an efficient vehicle that delivers plenty of thrills, too. So, what'll it be: a subcompact or an exotic Italian bike?*



✓ DUCATI HYPERMOTARD S



VS.

HONDA FIT SPORT



**THE ADRENALINE RUSH** that comes from piloting a sporty car or a hot-blooded motorcycle through a series of sinuous curves is a joy every gearhead craves. It's not all about gunning for flat-out, maximum speed. Smoothly connect each corner with the perfect combination of velocity and precision and the experience becomes more than just a cheap thrill—it's an accomplishment.

Such mechanized fun doesn't have to come with a sky-high price tag or an EPA fuel-economy rating in the single digits. In fact, for less than \$20,000 you can buy a vehicle that will serve as both a weekend

toy and a fuel-efficient commuter. The big question is, two wheels or four? We gathered together a pair of seemingly dissimilar vehicles—a high-strung, Italian-bred Ducati Hypermotard 1100 S and a sensible, versatile Honda Fit Sport—to see how they stack up when it comes to fun, practicality and fuel efficiency. We brought them both to Auto Club Raceway in Pomona, Calif., and ran them through our usual instrumented tests. We braved many miles of Los Angeles' famous traffic, and then, finally, we had some fun on Glendora Mountain Road, a 15-mile roller coaster of twisting, turning blacktop in Angeles National Forest. So can a sexy superbike compete with a fuel-efficient hatchback when it comes to value? Can the humble car match the bike for driving thrills? The results may surprise you.

#### • FOR WORK

The excitement of any PM test is tempered the moment we leave the office and hit the crowded freeways of Los Angeles. Yet the \$15,660 Ducati turns the rigors of rush hour into a real-life video game. The machine is proud to be loud. Twist the grip and the cannonlike exhaust lets out a bark that echoes off 18-wheelers and makes pedestrians jump. Sometimes it's good to be bad. The tremendous torque of the 1078 cc L-twin rolls on instantly. And with short gearing, we burst through holes in traffic. The downside to these thrills is comfort—we were saddle-sore in less than 100 miles. And there's no windscreen. Once clear of traffic—at 70 mph—the wind buffeting is fierce and tiring.

#### Specs



\$15,660	PRICE	\$17,580
1078 cc Twin/6M	ENGINE/TRANS	1.5-liter Four/5A
95	HORSEPOWER	117
397	WEIGHT (LB)	2520
48 mm Kayaba forks/ adjustable Ohlins shock	SUSPENSION F/R	MacPherson strut/ torsion beam
1.95	0-30 MPH (SEC)	3.47
4.02	0-60 MPH (SEC)	10.19
7.59	0-90 MPH (SEC)	22.49
12.2 @ 110.3	1/4 MILE (SEC/MPH)	17.4 @ 80.1
30.1	0-30 BRAKING (FT)	30.6
122.4	0-60 BRAKING (FT)	122.3
0.55	LATERAL GRIP (G'S)	0.75
48.9	FUEL ECONOMY (MPG)	29.8



DUCATI HYPERMOTARD S



HONDA FIT SPORT



#### ON THE WEB >

Submit footage of your own motorcycle and check out other bikers' rides at [popularmechanics.com/mybike](http://popularmechanics.com/mybike).



In contrast, the \$17,580 Honda Fit Sport, loaded down with luggage and test gear, made the grueling rush-hour test loop, well, easy. Compared to the Ducati, the Fit is like a Boeing Business Jet. The effortless five-speed automatic meant our feet were not fatigued by clutch work. And of course, the fully enclosed, climate-controlled cabin—not to mention the MP3-ready 160-watt audio system—kept stop-and-go frustrations to a minimum. The Fit is no Lexus, but it's a cocoon of silence compared to the bike. You arrive at your destination relaxed—not frazzled, with a bad case of helmet head.

The Hypermotard does hold one practical commuting advantage—lane splitting. The California Highway Patrol says lane splitting is “permissible but must be done in a safe and prudent manner.” We oblige. The Hypermotard has a tall, upright riding position—similar to a dirt bike’s. So visibility and maneuverability are excellent. The major disadvantage is the lack of room for people and their stuff. Yes, the Hypermotard can handle one passenger. But as a vessel to transport gear and people, the Fit claims an easy victory.

#### Strictly Business

The Honda’s analog gauge package is remarkably simple—and we like that. The Ducati uses a digital readout that’s difficult to see—and, like most bikes, it has no gas gauge.

#### Pipe Dreams

The Ducati’s beautifully crafted exhaust is routed underneath the seat and offers twice the number of pipes as the Honda for half the number of cylinders.

## • ON THE WEEKEND

**The Ducati produces** 95 hp and weighs just 397 pounds. The Fit delivers 22 more hp but has to haul more than an extra ton of metal, glass and rubber. Not surprisingly, the Ducati was the star of the dragstrip. Our hired gun, professional test rider Matthias Jezek, hustled the Hypermotard to 60 mph more than 6 seconds quicker than we could manage in the Honda. In fact, the Ducati reaches 90 mph before the Honda even gets to 60 mph—about two-and-a-half seconds sooner. That’s staggering. So it seems like the Fit must be no fun at all, right? We disagree. The Honda isn’t quick—heck, it’s downright slow. But that doesn’t mean you can’t have a blast on a really good slab of tarmac.

Glendora Mountain Road rises from roughly 750 ft at the base to around 3500 ft near the top. It doesn’t have long, sweeping curves but rather tight corners that reward a nimble machine. The Ducati is made for this road. Its long-travel suspension, breathtaking engine and nearly race-spec Brembo brakes make short work of switchbacks. But on test day, Glendora was a minefield. Recent rainstorms had loosened debris from above and caused dirt and softball-size rocks to roll down onto the road. It takes a special kind of bravado (or stupidity) to ride a motorcycle at 10/10ths when every corner hides a mudslide. And we did dial back our speed. Still, short of a full-fledged enduro, this Hypermotard was as well-suited to the challenging terrain as any ride.

One might have thought the Italian Stallion would have walked away from the lowly Fit on this road. But at almost every turn heading up the mountain, the Fit filled the bike’s rearview mirror. The handling balance and grip from this Honda is extraordinary for a car in its class. You can fling the Fit hard into the tightest corner, ride the brakes slightly to take the edge off the understeer and then power out to the next turn. It was surprisingly quick, especially on the downhill, where momentum makes up for the lack of engine power. The Fit actually arrived at the bottom of Glendora ahead of the Ducati—its front brakes nearly smoking. Fun? Oh yeah.

## • THE BOTTOM LINE

**So, which one offers the best bang for the buck?** There’s no easy answer. The Ducati and Honda are both fun, but we’d certainly crown the fire-breathing Hypermotard king of that battle. As a commuter, we’ll give the edge to the Fit. The Ducati can make better time, but the stiff seat and cramped foot-peg position mean this bike isn’t our first choice for a long-distance cruise. The Fit, on the other hand, would be comfortable enough for a cross-country Cannonball Run. The endgame comes down to fuel efficiency and price. Over our test route, the Honda returned a solid 29.8 mpg. But the high-strung, Italian-bred superbike delivered an incredible 48.9 mpg and cost about \$1900 less. That’s the tipping point. **Winner: DUCATI.**

PM




# Finding your inner Garage



WITH ONLY A CRAWLSPACE BELOW their house in Knoxville, Tenn., Tanya and Laurence Brown eyed their garage when they decided to add a home gym. "We both like to exercise," Laurence says, "but ever since we had our first kid, it's been hard to find time to go to the gym." With help from the DIY Network's *Garage Mahal* crew and PM, the couple crafted a wish list of equipment that provided everything from resistance training to cardio. The hardest part, besides

Photographs by Marc Joseph





The DIY Network's *Garage Mahal* crew and the author—PM's Detroit editor and home-improvement enthusiast—turned this two-car garage in Knoxville, Tenn., into a gym with monkey bars, climbing wall, weight bench and more. To see the transformation, turn the page.

With some creativity and elbow grease, a garage can be a lot more than just a place to park cars. **BY LARRY WEBSTER**

clearing out piles of unused junk, was fitting everything into the tight, two-car space. "We concentrated on the typically unused areas, like the walls and ceiling," lead contractor Jim Brunton says. "We didn't want it to feel cramped." In just three days, the crew craftily fabricated and installed a fitness center with enough varied gear to work the entire body and stave off boredom. Plus, nearly everything can be quickly deployed and stored, leaving enough room to park a car.

**before**



1

### Space-Saving Cabinets

The seemingly simple, box-constructed entertainment center performs several functions. The one-way mirror **1** hides a 42-in. flat screen that shines through when the TV is turned on. The weight bench fits into the space **2** underneath the TV shelf. Flanking shelves hold items generally underfoot, like towels, hand weights and resistance bands.



2

### Rack System

*Garage Mahal* host Brian Corsetti (below) works on the support for the combined massage table/Pilates springboard. The bouncy seat for the baby (bottom, **3**), the heavy punching bag **4** and the speed bag **5** mount on an easily sourced barn-door sliding track. Each item attaches to a set of sliding wheels and is held in place with a simple locking pin. Perforated angle iron that's generally used to mount garage-door openers secures the track to the ceiling via lagbolts driven into the rafters. When not in use, the gear slides into a custom-made closet **6**. And since the Browns still needed to store a few tools, the crew sprinkled in plenty of racks and storage shelves **7**. Tough, easily installed, stick-on floor carpet cushions the concrete floor, and swiveled lights offer less glare than bare bulbs.





### Monkey Bars

They taught an important lesson: Check rafter spacing before you do anything. The rack of pine bars **8** had to be repositioned farther away than intended from the climbing wall so it lined up with the rafters. No drywall anchor can safely support a human. Another key lesson: The more inviting the gym, the more likely you'll be to exercise. The refrigerator **9** removes the temptation to get sidelined on an extended water break.

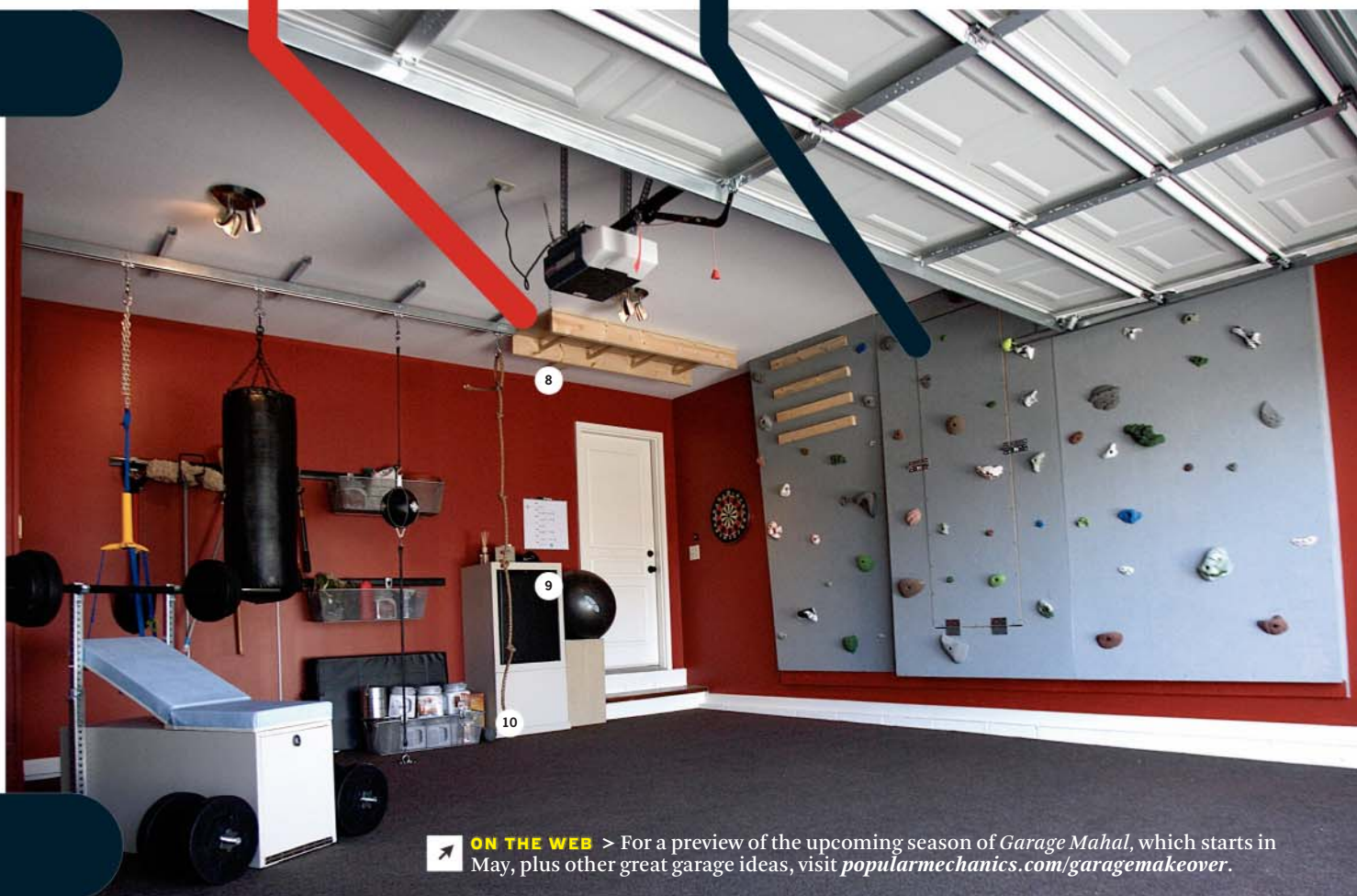
### Climbing Wall

Saving space by combining several functions is always a smart idea. The sliding track for the bouncy seat and punching bags also supports a climbing rope **10**. The clever and challenging climbing wall hides both a Pilates springboard **11** and a massage table **12** in its center section. The crew used  $\frac{3}{4}$ -in. plywood to safely secure the hand- and footholds. Lagbolts fastened the wall's wood frame to the studs. The fold-down massage table is hinged at the bottom; the Pilates board is mounted to the wall behind the table. The trickiest part was making the table fit precisely into the wall so it didn't rattle when folded.



### Parking Space

Larry Webster, PM's Detroit editor and *Garage Mahal* hired hand (below, left), works on the one-way mirror frame. Homeowner Laurence Brown confirms that, yep, it's still a garage.



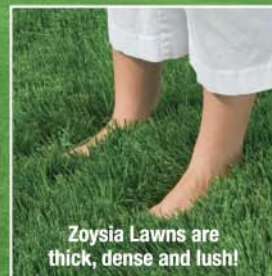
**ON THE WEB** > For a preview of the upcoming season of *Garage Mahal*, which starts in May, plus other great garage ideas, visit [popularmechanics.com/garagemakeover](http://popularmechanics.com/garagemakeover).



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# DIY Home

## Grow Up

RAISED BEDS TAKE THE  
HASSLE OUT OF HORTICULTURE.

BY FIONA GILSENAN

**Experienced gardeners use raised beds to sidestep a long list of gardening challenges. These controlled experiments in plant parenthood are so easy, in fact, that they're also well-suited to novices picking up a shovel for the first time.**

Bad dirt is out, because you fill a raised bed with a customized soil-and-compost blend. Drainage is built into the bed walls, which hold the soil in place to keep erosion in check. Greater exposure to the sun warms the bed, which allows more plant diversity and extends the growing season. Plants can be



spaced closely together, so yields go up, water-use efficiency is maximized and weeds are crowded out. Finally, raising the soil level by even a foot reduces the back-bending effort needed for jobs such as planting, weeding and harvesting.

Beyond the ease is the control—as you grow your favorite foods, you feed and soak your plants with just what they need for optimum growth.

A raised bed is most productive and attractive as a bottomless frame set into a shallow trench. The sides can be almost any durable building material, including rock, brick, concrete and interlocking blocks. Watering troughs or claw-foot tubs can work, as long as they have the capacity and drainage.

But by far the most common material for raised beds is lumber. The major caveat, since raised beds are often used to grow edibles, is to steer clear of wood preserved with toxins. Avoid creosote-treated railroad ties; opt instead for naturally rot-resistant cedar or redwood. The EPA considers wood infused with alkaline copper quaternary (ACQ) to be safe for food crops, but if you use this pressure-treated wood you may want to line the bed interior with landscape fabric—an air-and-water-permeable screen—to prevent soil contact. Whether using pressure-treated or naturally rot-resistant wood, put the bed together with galvanized or stainless screws or bolts.

## Location, Location

A 3 x 6-ft bed should be wide enough to support sprawling tomatoes, but narrow enough to reach easily from both sides. The ideal height is 1 to 2 ft tall—you can go taller, but you need a considerable amount of soil to fill a 3-ft-high bed. If possible, build more than one bed, which makes it easier to rotate crops and meet the watering needs of specific plants. Aligning beds in straight rows simplifies the installation of an irrigation system.

Finding a flat spot spares a lot of digging—you want the walls to be

level. In general, a north-south orientation takes full advantage of available light. Stay close to the kitchen, but avoid sites shaded by the house or beneath messy trees. Leave at least 18 in. between beds for walkways, or 2 ft if you need room for a wheelbarrow or lawnmower.

## Planning, Building

To prepare the site, get rid of turf and weeds. Outline the bed dimensions on the ground with chalkline or

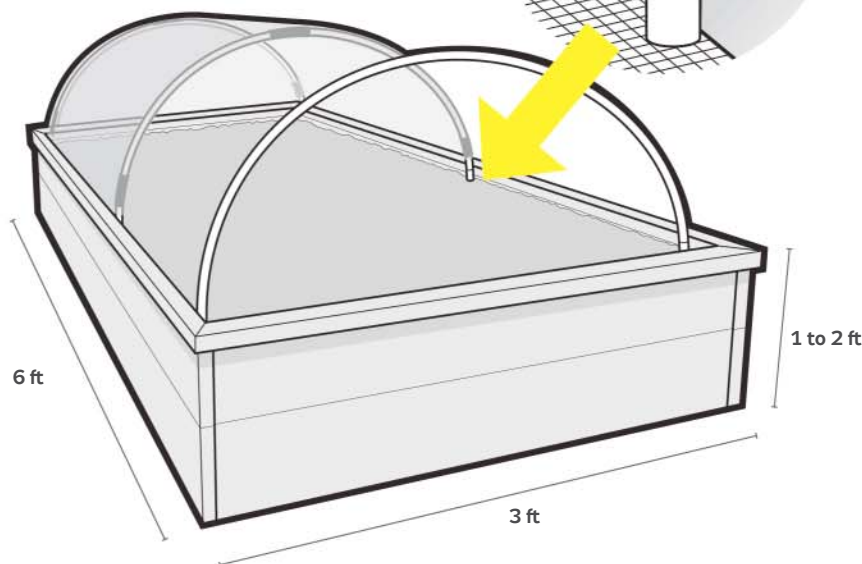


**Miter lumber at 45 degrees to make the cap railing—a place to sit while weeding and harvesting. Bed covers ward off insects and keep plants warm in cool weather.**

**Use galvanized pipe straps to mount 1-in. PVC pipe inside the bed walls. Cut ½-in. flexible PVC tubing twice as long as the beds' width. Bend it, mount it and clip a cover in place.**

string, then dig with vertical strokes along the outline, just deep enough to bury about half of your first course of lumber. Raised beds are designed so water trickles down, eliminating most of the problem of poor drainage. But if your only viable location is bogged in a marsh, you can prevent the “bathtub effect” by digging a few inches deeper and putting a layer of coarse stone or pea gravel in the excavation. (You can also install perforated drainage pipes in trenches under or around the bed, or just drill weep holes at the base of the sides.) Likewise, if there is no turf between your beds, put down some landscape fabric and cover it with pavers or a layer of gravel to improve drainage—after running out in the rain for a fresh bell pepper, you’ll appreciate the mud-free shoes.

Level the earth or gravel layer at the bottom of the bed, then put down a layer of weed-suppressing landscape fabric that extends to the outer edge of the wooden frame. Now is also the time to think about pest control. “The rich soil in a raised bed has worms and





other delicacies that attract moles, and gophers and voles relish young veggie roots," Sausalito, Calif., garden designer Tom Wilhite says. "To keep out burrowing pests I always recommend a bottom layer of hardware cloth"—a mesh grid of steel or galvanized metal.

Build each wall separately, then fasten them together and put the bed into position. Raised-bed builders often sink posts into the ground for stability, either at the inside corners of the bed or halfway along the side walls. These help hold the bed

in place, but can also reduce the outward pressure that a full bed exerts on the frame, which can dislodge the lumber after a single season. A cap railing that runs around the top of the bed ties everything together. Plus, it provides a handy place to set down gardening tools while working, or, when you're done, a seat to admire the fruits of your labor.

## Greenhouse Effect

A simple framework of hoops and a lightweight cover can extend your growing season in cool areas, conserve moisture in dry areas and protect plants from birds or insects. Use clear polyethylene film to raise soil and air temperatures in early spring or fall—to get an early start on heirloom tomatoes, for instance, or to try your hand at exotic squashes. But be careful not to bake your plants on warmer days. Remove the cover or slit vents in it to avoid excessive heat buildup. For pest control, cover the bed with bird netting or with gauzelike fabrics known as floating row covers, which keep out flying insects but let in both light and air.



**Don't fill the bed with dirt from the garden. Instead, use peat moss, compost or a soil mix for planters. Use a 2 x 4 to level the soil, then plant.**

## Automate, Irrigate

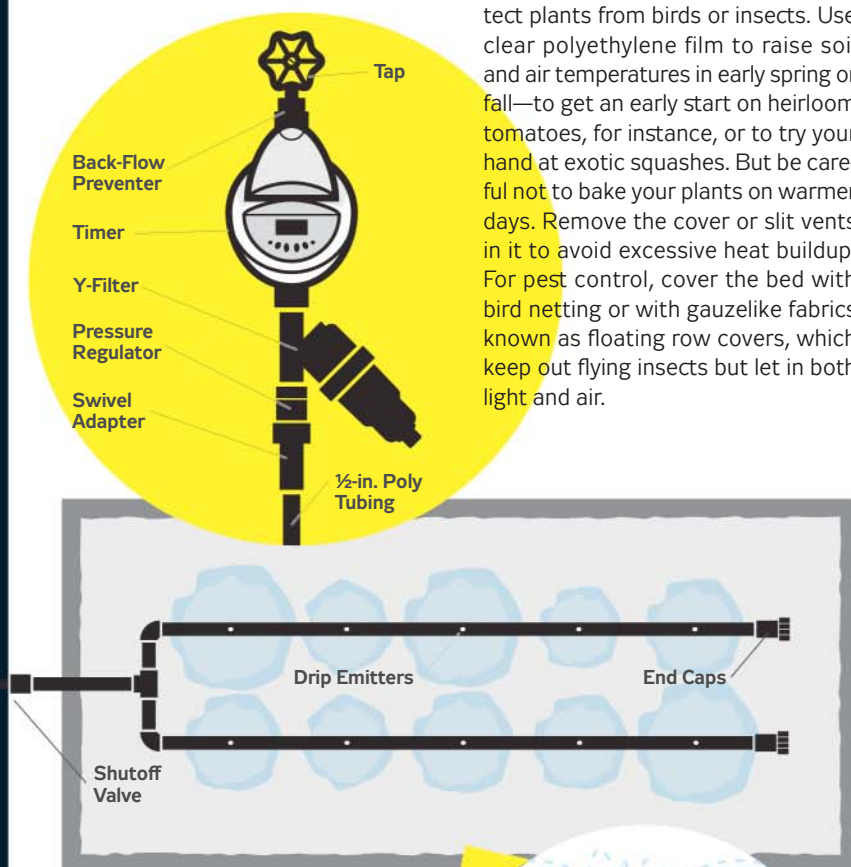
Once you add an automatic watering system to your raised-bed garden, you're free to plant, weed and harvest. A simple micro-irrigation setup ensures that plants get water consistently—especially important for seedlings and leaf crops such as lettuce. "The sides of raised beds heat up quickly in the sun, baking the moisture out of the soil," Wilhite says. "Irrigation delivers the water evenly and gently. You can set your timer to water early in the morning—less will evaporate, and you resist disease."

A basic setup starts with a faucet or hose-bib attachment that is essentially a series of valves that prevent back flow into the plumbing, filter the water and control the water pressure.

These valves are designed with 1-in. or 3/4-in. connections. From these, attach supply lines of flexible 1/2-in. poly tubing. The tubing's accessibility makes it easy to check for leaks and repair damage from punctures or bursts. To protect the tubing, bury it a few inches and cover the line with mulch.

Lay the tubing along the beds in lines 12 in. apart. Fit sections together with compression elbow and T-fittings. Install drip emitters at 12-in. intervals along the length of the tubing for even delivery of moisture to plants. Low-volume sprayers or misters on risers can also be used, but these lose more water to evaporation. Close the ends of each line with hose-end plugs and caps. Then sit back and let the system water for you.

**PM**



The simplest drip-irrigation setup uses flexible 1/2-in. poly tubing. It installs easily, it's inexpensive and it can easily be repaired if damaged.

Drip emitters spaced evenly at 12-in. intervals send water to the plants' roots throughout the bed. Install spray emitters to give leafy greens a rinse above the soil's surface.

# How Your **House** Works

## Window Theory

A WINDOW CAN BE, BASICALLY, A HOLE IN THE WALL. OR IT CAN LOOK GREAT WHILE CUTTING HEATING AND COOLING LOSSES. YOUR CHOICE.

**Windows are complex.** A new model may consist of wood, metal, plastic, glass, mineral oxides and perhaps an inert gas. Yet even a well-insulated unit delivers an R-value no better than an uninsulated wood-frame wall's (roughly R-4 to R-5). And a house can lose nearly 12,000 Btu per hour, or about 10 percent of a heating system's output, just through these leaky openings. That means there's a lot at stake when it comes to choosing, installing and sealing windows.

Adding storm windows cuts heating losses from drafty windows in half, and replacing them with an insulated product pares the losses still further. Finally, a modern unit holds in heat, reflecting it from you and your heating system back into the room. It seals out drafts and fends off summer sun.

Here's what you need to know.

*by* **ROY BERENDSOHN**

*photograph* **BY FILIP KWIATKOWSKI**



GATEFOLD **PULLOUT**



PLEASE  
CUT  
HERE

### Siding

The first line of defense in preventing air and moisture leaks is the siding. The larger the gap where it meets the window, the larger the opportunity for drafts and moisture to make their way into the wall cavity or house.

Flashing tape over top of house wrap, tape on sides

Side flashing tape applied over nailing fin

### Flashing Tape

Flashing tape is, as its name suggests, a sealing material applied on the outside of the nailing fin, sealing the joint between the fin and the house wrap.

It protects against both air and moisture penetration.

Insulated Glass Sash

Nailing Fin

### Window

A modern flanged plug is a hole cut into the house. The house wrap is slit so the nailing fin is tucked under. The fins on the bottom of the house

**No Pane, No Gain** The tendency of a window to let heat pass is described as its U-factor—lower is more energy-efficient. It's the inverse of R-value, which describes insulation's resistance to heat flow; higher is better. Adding a second piece of glass dramatically improves the window's U-factor. While a single-pane

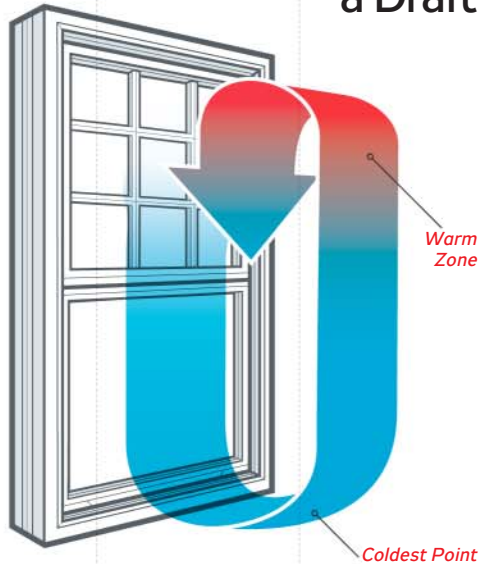
window is rated at 1.1, a second pane cuts the U to the range of 0.47 to 0.63. Filling the space between the panes with argon instead of air drops it to 0.37. Argon is a better insulator than air, a distinct advantage of insulated glass compared to a storm window installed on the outside of the house.

Glass

Sash

Insulated Spacer

## Anatomy of a Draft



In winter, the inner surface of window glass can be 5 to 20 F cooler than the adjacent indoor air, depending on the window's thermal efficiency and how cold it is outside. Indoor air cools as it passes over the window and sinks, producing an uncomfortable drafty zone. Insulated glass with a low U-value is warmer and improves comfort near windows.

Also, the larger the glass surface, the more it needs a low-E coating, a microscopically thin layer of metal oxide that reflects back infrared energy. Without the coating, the heat flowing out from your body would flow to and through the glass, increasing your discomfort. But a low-E coating bounces the infrared energy back, so you feel warmer.

**Hole-in-the-Wall Gang** Take a leaky double-hung window, with each sash measuring 35 x 26 in.—a pretty good-size window, in other words. With a gap around both sashes and at the parting rail between them, you have the equivalent of a significant hole in the wall.

Sash Gap

$\frac{1}{32}$  in.

Equivalent Hole

6.5 sq in.

$\frac{1}{64}$  in.

3.27 sq in.



## Instant Gratification

Few window upgrades are as easy and useful as sealing out drafts with peel-and-stick weatherstrip. First, use spray cleaner and remove dirt and grease from the jambs or sash. When the parts are dry, cut the weatherstrip to length, peel off its plastic backing and press the strip's sticky surface into place. Use V-shaped strips (shown) on window jambs; use bulb-shaped strips (shown) on the window's top or bottom edge. A \$5 roll of the material is enough to seal two or three typical windows.

REPLACING WINDOWS SURE, WEATHERSTRIPPING HELPS TO REDUCE DRAFTS. BUT WHEN LARGER ENERGY SAVINGS ARE CALLED FOR, THERE ARE THREE COMMON OPTIONS.



### New-Construction Window

- // **What:** A new-construction window used in an existing house.
- // **Expect:** Installation produces need for exterior and interior repairs.
- // **Payoff:** Major energy savings, good looks, tilt to clean.
- // **Cost:** \$11,000 to \$15,000 for 20 windows, installed



### Tilt-Wash Vinyl Replacement Window

- // **What:** An insulated window used in the existing jamb.
- // **Expect:** Quick installation. Reduced glass area due to smaller sash.
- // **Payoff:** Fewer drafts, energy savings, tilt to clean.
- // **Cost:** \$6300 to \$8800 for 20 windows, installed



### Storm Window

- // **What:** Sliding window in a frame; mounts on top of existing window.
- // **Expect:** Fast installation—usually one afternoon.
- // **Payoff:** Fewer drafts, improved energy savings.
- // **Cost:** \$2000 to \$2400 for 20 windows, DIY installation



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# Homeowners Clinic

by Roy Berendsohn

Q + A



## Closet Solutions

**Q** Our closets are packed and overflowing. We were thinking of renovating them with wire shelving and baskets, but we've also seen some wood cabinets for closets. Which is better? Is installing these closet systems difficult?

**A** It's not really a matter of which system is better, because both can work well. You need to decide which style meets your cost and design requirements. A basic wire-shelf setup is less expensive than cabinet systems, but the latter option provides a neater, more finished look. In most cases, you can install any of these organizers using nothing more than a cordless drill and simple hand tools.

If you're up for a challenge, though, consider building your own system. Inexpensive hardwood and softwood lumber, or plywood with some solid-wood edge banding, can yield a very attractive closet, especially when you combine it with well-designed hardware. Woodworking-supply outfits such as *rockler.com* offer attractive accessories, including sliding racks and garment hooks, while sites such as *kitchensource.com* sell a variety of sliding baskets. Doing it yourself can be more satisfying, and it will ensure that you use every cubic inch the way you want—not the way some closet-organizer company envisioned it.

While you're upgrading the space inside the closet, don't ignore the door. Swinging hollow-core and solid wood doors can be pressed into service to support

## 3 Steps for Better Closet Organizers



*Closets are often framed sloppily, with walls that are neither square nor plumb. Once I even stripped away old drywall and found the closet had been framed with scrap lumber—turned sideways. Here's how to cope.*

**1.**

Before you start building shelves and installing drawers, measure the walls carefully and check for square and plumb by holding a framing square in the corners and a level on the walls.

**2.**

If the walls are out of kilter, make your system self-contained—with sharp 90 degree angles and vertical sides. You'll waste a little space, but that's better than trying to custom-fit shelves and supports to a crazy quilt of angles.

**3.**

Even if the walls are plumb and level, don't count on regular stud spacing when it's time to install your new units—in many homes, you won't find it. Spend some time with a stud sensor and mark out the stud locations. This can save you a lot of fruitless drilling later on. — R.B.

tie racks, belt and coat hooks, small baskets, shoe hangers and a mirror.

## Painting Galvanized Steel

**I have two galvanized steel posts that hold up a sign with my house's street number. The paint is peeling off the posts. How do I repaint them?**

First, decide if you really want to paint the posts. A galvanized finish will form a corrosion-resistant surface that doesn't need paint. And it's tough to

paint galvanized steel, as your peeling paint illustrates. For one thing, it may come to have a slightly oily surface that will cause paint to lose its grip. Also, the zinc in the galvanized coating reacts with the paint resins in oil paints (alkyds), forming a soapy substance. Known as saponification, this process will peel oil-based paint like nobody's business. It might be simpler to let the rest of the paint peel off and leave the posts alone—or blast off the

remaining paint with a pressure washer. (Don't pull out a sander, though: You can accidentally scour right through the zinc layer.)

If you do want to paint the steel, start by thoroughly washing the surface to remove oily residue, oxides and dirt. Buy some TSP, otherwise known as trisodium phosphate, at a hardware store, and mix this powdered cleaner at a ratio of ½ cup to 2 gal of hot water. (This will produce an alkaline cleaner with a pH of 11.5.) Scrub the surface using a plastic brush or an aggressive plastic scouring pad, and rinse thoroughly with hot, clear water. Let the surface dry. Some painters use steel wool for this job, but once again there's a risk of cutting right through the galvanized layer.

Next, lightly abrade the surface with the plastic pad or abrasive paper to ensure a uniform roughness, remove loose paint with a scraper and sand the edge of peeled paint to feather its edge to a smooth transition. Brush off the dust and rinse the posts. Then, once the surface has thoroughly dried, apply an acrylic primer. Use a product formulated to be compatible with galvanized metal. One example is Rust-Oleum Stops Rust Aluminum Primer. Top-coat that with a professional-quality gloss or semigloss acrylic paint.

### ■ KNOW YOUR STUFF

## Concrete Fasteners for Any Application



### Powder-Actuated Fastener

**What:** A 22-cal. shell to drive a fastener up to 3 in. long. You strike a specialized tool (the Ramset HD22) with a hammer to detonate the charge and drive in the fastener.

[ramset-redhead.com](http://ramset-redhead.com)

**Advantages:** Lightweight and fast to use. **Disadvantages:** Loud; fasteners are difficult to remove—in most cases they must be cut off.

**Cost:** Tool, \$22; loads, \$4 per box of 25; drive pins, \$5 per box of 25



### Tap-and-Set Hardware

**What:** Plastic hooks, rings, sockets and pins that are pushed into a hole and then tapped with a hammer to break open their self-contained adhesive vial.

[tapset.com](http://tapset.com)

**Advantages:** Simplifies mounting of durable (and paintable) plastic shapes to concrete. Shapes can be cut off with a chisel if they are broken or no longer needed.

**Disadvantages:** Requires a hammer drill; drilling creates dust.

**Cost:** \$10 to \$12 for a package of two



### Concrete Screw

**What:** A high-strength screw that is driven into concrete. [tapcon.com](http://tapcon.com)

**Advantages:** Simple and extremely strong; screws can be removed (but not reused).

**Disadvantages:** Requires a hammer drill; drilling creates dust.

**Cost:** \$4 for a package of eight

## Dumping the Pump?

### How long do sump pumps last?

**I have one that's 10 years old, and I'm wondering if I should preemptively replace it.**

That's a good question with no clear answer, at least as far as I'm concerned. I've seen heavy-duty pumps that looked as sound after 10 years as the day they were lowered into the murky depths of a basement sump. But then, some years ago, I saw a sump pump fail after only a couple of years when its stainless-steel band clamp rotted a groove through its cast-iron body. (Stainless steel put in contact with cast iron and submerged underwater sets up a powerful corrosion cell.)

If the pump doesn't run very often, check it a couple of times a year by pouring a few gallons of water into the sump. The mechanism should run quietly and robustly. If it sounds



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suspicious, check it. To test the switch, Tom Schere, an engineer at North Dakota State University, suggests slowly pouring water into the sump, which will cause the switch to turn on and off a few times.

## Drafty Fixtures, Tricky Electricals

**When I removed a bulb from a recessed light in my living room, I felt cold air gushing from the attic into the room. I'm concerned about energy loss through these fixtures. What should I do?**

Recessed lights are notorious for leaking air. In the summer, conditioned air streams past them and into the attic or a ceiling cavity. In the winter, the same thing happens with heated air. In the case of the attic, this warmed air can contribute to ice dams on a roof.

Although it's a major undertaking, the most electrically safe and energy-

efficient route would be to install airtight retrofit lights designed for insulation contact and then get into the attic and seal all air gaps and add extra insulation. Unfortunately, this could involve significant wiring work and expense.

Modern recessed lights are designed to be operated on what's known as 90 C (194 F) wiring, but if your house was built before the mid-1980s, chances are good that the lighting-circuit wiring has a lower temperature rating. It won't be up to the job of safely supplying current to the new fixtures. You or an electrician would need either to install new wire all the way from the switch to the fixtures, or at least splice 90 C wire into the lighting circuit and lead it to a junction box in the attic.

There are simpler, low-cost alternatives. For example, you can improve the energy efficiency of the lights by installing gaskets under their trim, or you can install an airtight trim that

retrofits into the existing can. (The can is the cylindrical metal housing that makes up the body of the light.) There is also a compact-fluorescent-light retrofit kit from Technical Consumer Products ([tcpi.com](http://tcpi.com)). This kit does cut air loss through the fixture, but its primary function is to reduce energy use by providing for a compact fluorescent bulb and compatible reflector in many common recessed lights.

A word of caution is in order. Not all retrofit components are cross-compatible, nor are all retrofit components compatible with all recessed lights. The light's trim, can and light bulb all have to work together. The compatibility information is listed inside the can—when in doubt, contact the manufacturer. Whatever you do, be sure not to install a higher-wattage bulb in the fixtures after you've installed airtight components. Electricians call the practice "overlamping." It can lead to dangerous overheating, especially in older lights that don't have a thermal switch to detect high heats and cut power if necessary.

## Caulk for Glazing

**I have a 100-year-old house, and I've hired painters to paint it and refurbish its 40 wood windows. They say they're going to use caulk to repair the putty that the old window glass is set in. Is this a proper repair? I thought only window glazing would work for this. Please advise.**

If the painters literally meant caulk, then they're making a mistake. You should probably find somebody else to do the job. If, on the other hand, they meant gun-grade glazing compound, then they're doing the job right. This stuff is much like traditional knife-grade glazing compound, but it's extruded out of a cartridge inserted in a caulk gun. The traditional knife-applied version is scooped out of the can,



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kneaded into a roll and then carefully tooled onto the sash with a putty knife. The skill to do it neatly and quickly is a disappearing art.

## Doorstop Solution

**There's probably an easy answer to this. I want to replace the doorstops all over the house because the cheapo ones installed by the builder are ugly. I put a new one in a few weeks ago and scuffed it up by using pliers to twist it in the last couple of turns. There seemed no other way to grip the thing. Obviously, my wife wasn't pleased. Neither was I.**

Try peeling off the stop's rubber bumper. Under the bumper, some stops have a slot for a screwdriver tip cut into the shaft end. Other stops have a square base that allows you to slip an adjustable wrench over it.

## Home-Grown Power Problem

**We lose grid power a lot, and I've found that I can't operate my garage-door opener on the power supplied by my home generator. The opener works fine with grid power, but not from my generator. I'm stumped.**

We've been getting more of these reports, although most of them concern appliances. I suspect sensitive electronics are to blame. In one case, we learned from an appliance manufacturer that they equip their ranges with self-monitoring electronics that shut the appliance down if they detect a minor discrepancy in the supply voltage. It comes down to liability fears. Manufacturers take advantage of adding monitoring components that can prevent damage to the appliance or, in the worst case, an electrical fire. I can't blame them for installing this stuff, though it won't make your life any easier in a power outage.

Try this: Plug the garage-door opener into a power strip equipped with a power filter, and plug the power strip into the ceiling outlet that supplies the opener. If it works, you've solved your problem. If not, double check that the trans-

fer switch that the generator routes power through is properly installed. The problem could be as simple as a slightly loose connection.

## Storm-Damaged Trees

**Our trees took a beating this winter from repeated storms. We're about ready to begin our spring yard cleanup, but before we start, we thought we'd get some advice.**

If the damage is light and the trees are small enough that you can make repair cuts while standing on the ground, you can probably handle the work. If the damaged limbs are well up off the ground, call in a pro.

Trees that grow in sunny yards have codominant stems—they have more than one stem or large branch that competes with the main stem. A tree that grows in a forest will be tall and straight because it has to push up through a shady and crowded environment to reach sunlight. It's difficult to assess and safely treat storm damage to a tree with codominant stems. To the untrained eye, it can look like nothing more than a tangled mass. If you decide to tackle the job, first do your homework. Learn how to identify and treat different types of damage by looking on the Web at visual references posted by state agricultural extension services and universities with horticultural programs. If you're going to hire a professional, it's important to distinguish between a company that specializes only in tree removal and one that employs or is owned by a certified arborist—a specialist trained in tree care (visit [isa-arbor.com](http://isa-arbor.com) to learn more). Only an arborist can assess the best way to deal with the damage and to ensure a tree's future health.

PM

**GOT A HOME-MAINTENANCE OR REPAIR PROBLEM?** Ask Roy about it. Send your questions to [pmhomeclinic@hearst.com](mailto:pmhomeclinic@hearst.com) or to Homeowners Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.



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# DIY Auto

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## Silence That Squeal

THE SERPENTINE BELT IS  
A CRUCIAL PART OF THE  
ENGINE ASSEMBLY. HERE'S  
THE RIGHT WAY TO  
REPLACE IT. *BY MIKE ALLEN*

**There's a squeal** emanating from underneath your hood—and it doesn't sound good. The noise started a few months ago, on a gray and rainy morning, but it went away before you even pulled out of the driveway. Problem solved, right? Sorry pal. Unfortunately, the noise was back the very next morning, and this time it lasted all the way to the corner of your block. You lifted the hood and zoomed in on the offending racket—it was the serpentine belt. As the



This belt, obviously past its prime, ran for 115,000 miles, and it was still within the tension limits specified. It's toast, regardless.

weeks dragged on, your morning commute got noisier and noisier every day. Then you began to hear it on the way home too. Now it's a constant reminder to replace the belt. Soon.

Most modern cars don't use old-fashioned V-belts anymore. In the '70s, as more and more cars were optioned with lots of power-hungry accessories running off the crankshaft pulley, it often became necessary to have as many as four V-belts, each running a different gizmo. There just isn't room for that many belts and pulleys anymore—not to mention, this belt configuration means that it's a service nightmare to replace just the inner belt by itself. You'd have to remove the other three first—not a fun job.

There are several advantages to

the new style of serpentine belts. A single belt, winding its way through a forest of pulleys, can now drive every single engine accessory at the same time. A single belt only an inch or so wide saves 3 or 4 in. of engine room real estate. Better still: Most of the serpentine-belt installations use a spring-loaded tensioner pulley that keeps a constant preload on the belt, eliminating the need to adjust the tension. If you've ever needed three hands and a tire iron to pry an alternator away from the block while simultaneously tightening the adjustment bolt-and-nut combo, you'll appreciate what a giant leap forward that is.

There's one last, very compelling advantage to serpentine belts: They don't wear out, at least not for a really

long time. A fresh belt will probably last 150,000 miles without any maintenance at all. Contrast that with the expected 40,000- to 50,000-mile life span of a heavily loaded V-belt.

## Failure Modes

So when, exactly, does one of these belts need to be replaced? Usually, you get plenty of warning before you hear the final Bad Noise, to wit, that squealing. A squealing noise is indicative of a problem, but might not require replacement of the belt. Misaligned pulleys or a seized tensioner or idler pulley can generate some noise as well.

A belt that's starting to disintegrate will show damage to the ribs or cords, which can usually be seen without dismantling anything. But you might need a flashlight and a dental mirror to see the fraying or cracking.

## Fresh Belt

Start by studying the old belt's routing, which should be easy if the belt is still in place. But it's probably not so easy to spot if the belt is wadded up like macramé next to the a/c compressor's mounting bracket. Fear not: There should be a belt-routing placard under the hood. If the car has had bodywork or been repainted, the placard might have been covered. Look in the owner's manual; there's usually a routing diagram. With a half-dozen pulleys to



An ordinary  $\frac{3}{8}$ -in. extension and ratchet is used to unload the tensioner. Then you can just unthread the belt from around the pulleys.

Use a straight-edge to see if all the pulleys are coplanar and square. If they're not, the new belt won't last long.



We used thread-locking compound to seal the new bolt that was provided with the tensioner.







**Torque the new tensioner to the specified degree of tightness. Yes, that means with a torque wrench, not your carefully calibrated elbow.**

**The hash mark on the body of the tensioner should fall between the high- and low-tension marks when the new belt is installed.**

choose from, it's possible, sometimes, to install the belt the wrong way. It might look right, but spinning the a/c compressor or water pump backwards isn't good. If the belt is hard to install or seems to fit poorly, you may have it routed incorrectly. Don't freak—sometimes the water pump is driven by the flat, back side of the belt. Any pulley that has grooves on it is intended to contact the grooved side of the belt. If you need to, sketch the correct routing down before you remove the old belt. As a last resort, check the shop manual.

Most cars provide a common  $\frac{3}{8}$ -in.-sq hole in the tensioner's arm to release the tensioner. Simply use a ratchet to loosen the belt, and unthread it from the pulleys.

Inspect the belt for damage. Cracks across the ribs are the most common indication of a belt that's simply at the end of its life span. Little rubber bands of rib, tufts of fiberglass reinforcing belt

or disintegrating belt edges are indications of a problem with the pulleys, idlers or tensioners. A high-mileage belt that's just looking worn can simply be replaced. If there are other indications of damage from misalignment, get out the straightedge and make note of what isn't square.

A bent accessory-mounting bracket can make a pulley crooked, and you'll need to realign it. A steel bracket could be bent back into place, but a couple of shim washers might be a better option. If you're replacing a belt because of a fried alternator or seized a/c compressor, don't assume the new accessory or bracket will run true either.

Check the tensioner. The pulley should freewheel smoothly. The spring should have an appropriate amount of tension (which you can check with a belt tension gauge once the belt is installed), and there should be no friction in the pivot. Tensioner assemblies are usually not very expensive. Ditto

for any idler pulleys, which should spin freely. We replaced the tensioner on our Suburban and added a drop of thread-locker to the bolt. The tensioner came with a new bolt—nice.

Is the area where the belt lives oily? Engine oil will rapidly degrade the rubber in the belt. Repair any leaky engine seals, like the crankshaft or camshaft front seal, or any gaskets—lest the new belt should go south in short order. Clean up any old oil too.

Check all the pulleys as well. Old rubber or dirt can build up in the bottom of the pulley grooves. You may need to clean the grooves with brake cleaner or a wire brush to remove any debris.

## Buttoning Up

It's a simple matter to install a new tensioner and reinstall the belt, holding the tensioner slack with one hand as you thread the last pulley. Once the belt's in place, start the engine and let it idle for a minute or two. Check the belt tension by looking at the tensioner arm—the mark cast into the tensioner body will fall between the high and low marks if the belt is the correct part number and is installed properly.

If you removed any of the radiator shrouding to access the belt, don't neglect to reinstall it once you've finished. You certainly don't want any new noises coming from under the hood.

**PM**

## Waterproofing Connectors



In spite of that red O-ring, water and sand have infiltrated this connector. Use dielectric grease to prevent this problem.

**Q** The electrical connection to my car's radiator fan quits every few weeks. It's fine for a while, but then it dies and I have to take it apart and clean the connection again. Any ideas?

**A** Moisture isn't supposed to be able to infiltrate most underhood electrical connections, but sometimes it does. Could be a bad seal, a cracked connector body or a missing O-ring. Dirt can worm its way in as well. Examine the connector closely for issues. Clean the contacts with aerosol contact cleaner, then fill the cavity with dielectric grease. Yes, I know: How can dielectric grease—an insulator—improve the electrical performance of metal-to-metal contacts? The springy contacts will wipe away any grease as they're inserted, allowing contact. That grease, in turn,

will prevent moisture from getting to the bare metal, and keep nonconductive oxides from building up. One side benefit is that the connector will be less likely to stick and become difficult to open years down the road. Nonetheless, once the corrosion is bad enough to dissolve the conductive plating from the springy steel or brass contacts, you'll just have to remove the electrical contacts crimped onto the wires and replace them with fresh ones.

### Faulty Logic

**A few months ago you described how to repair a leaky rim. I think it's easier to fix porous rims by just installing a tube. This also helps seal rims that aren't cleaned up at the bead surface before they're mounted.**

Bad idea. Don't do it.

Specifically, don't ever install a tube in a tire that says "tubeless" on the

sidewall, except in an I-have-to-get-home emergency. Here's why:

- The ribbed inside surface of the tubeless tire is not finished to accept a tube. Tube-type tires have smoother surfaces, without any outstanding ribs or texture to wear out that tube prematurely.
- The tube will make the sidewall of the tire stiffer. Aside from the poor ride, this will alter the handling characteristics of the vehicle. A rear tire stiffened by a tube may well cause oversteer, pitching you and your family off into the weeds. Ditto for a front tire, which could understeer off the road.
- A tubeless tire wearing a tube will run substantially hotter when it's driven at high speeds, potentially hot enough to fail—certainly hot enough to shorten the life span of both the tube and tire.

Also, I don't find the use of a tube to be an adequate fix for a lazy tire technician not having properly cleaned the bead-seat surface of the rim before mounting a tire.

### Idle Thoughts

**I left the van running by mistake for 12 hours while it was parked. Will this hurt my vehicle? It drove fine afterwards, but I didn't know if letting a vehicle idle for that long could cause damage.**

In a perfect world, cars would not idle, ever. Idling serves no purpose. Okay, I'll make one exception to that: If it's really cold out and you need to warm



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Like a picked flower cut from the source, we gradually wilt physically and mentally and become vulnerable to a host of degenerative diseases, that we simply weren't susceptible to in our early adult years.

Modern medical science now regards aging as a disease that is treatable and preventable and that "aging", the disease, is actually a complication of various diseases and pathologies, from everything, like a rise in blood glucose and pressure to diabetes, skin wrinkling and so on. All of these aging symptoms can be stopped-and rolled back by maintaining Growth Hormone levels in the blood at the same levels HGH existed in the blood when we were 25 years old.

There is a receptor site in almost every cell in the human body for HGH, so its regenerative and healing effects are very comprehensive.

Growth Hormone first synthesized in 1985 under the Reagan Orphan drug act, to treat dwarfism, was quickly recognized to stop aging in its tracks and reverse it to a remarkable degree. Since then, only the lucky and the rich have had access to it at the cost of \$20,000 US per year.

Many in Hollywood's glamour sets, who never seem to age like you or I, have a special secret to tell, and even space pioneer and US Senator John Glen stays vital with HGH.

The next big breakthrough was to come in 1997 when a group of doctors and scientists, developed an all-natural source product which would cause your own natural HGH to be released again and do all the remarkable things it did for you in your 20's. Now available to every adult for about the price of a coffee and donut a day.

GHR now available in America, just in time for the aging Baby Boomers and everyone else from age 30 to 90 who doesn't want to age rapidly but would rather stay young, beautiful and healthy all of the time.

The new HGH releasers are winning converts from the synthetic HGH users as well, since GHR is just as effective, is oral instead of self-injectable and is very affordable.

GHR is a natural releaser, has no known side effects, unlike the synthetic version and has no known drug interactions. Progressive doctors admit that this is the direction medicine is seeking to go, to get the body to heal itself instead of employing drugs. GHR is truly a revolutionary paradigm shift in medicine and, like any modern leap frog advance, many others will be left in the dust holding their limited, or useless drugs and remedies.

It is now thought that HGH is so comprehensive in its healing and regenerative powers that it is today, where the computer industry was twenty years ago, that it will displace so many prescription and non-prescription drugs and health remedies that it is staggering to think of.

The president of BIE Health Products stated in a recent interview, I've been waiting for these products since the 70's. We knew they would come, if only we could stay healthy and live long enough to see them! If you want to stay on top of your game, physically and mentally as you age, this product is a boon, especially for the highly skilled professionals who have made large investments in their education, and experience. Also with the failure of Congress to honor our seniors with pharmaceutical coverage policy, it's more important than ever to take pro-active steps to safeguard your health. Continued use of GHR will make a radical difference in your health, HGH is particularly helpful to the elderly who, given a choice, would rather stay independent in their own home, strong healthy and alert enough to manage their own affairs, exercise and stay involved in their communities. Frank, age 85 walks two miles a day, plays golf, belongs to a dance club for seniors, has a girl friend again and doesn't need Viagra, passed his drivers test and is hardly ever home when we call - GHR delivers.

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up the vehicle to clear the windows of condensation so it's safe to drive, then fine, let it idle. Extended idling is hard on camshafts and lifters, harder than running near redline. In fact, some hybrids rarely idle. Even when the engine is turning and the vehicle is not moving, the engine is loaded down by the alternator, producing current to charge the batteries and, ultimately, save gas. Most hybrids shut the engine off at traffic lights to reduce the proportion of time spent at idle, saving fuel.

Ah, but about your van: It's fine. Modern cars don't overheat at idle, and the things that wear out, wear out slowly. It's common practice in very cold climates to let diesel engines (which consume very little fuel at idle) run all night long if they're going to be hard to start the next day. And police cars often spend many hours idling when parked at roadside accident scenes in order to power all those flashing lights.

## Mind Your Manners

**My 2003 Toyota Camry XLE makes a gurgling sound under the dashboard when I slow down or accelerate. (It's easier to hear upon deceleration because the engine is quieter.) Any ideas before I go ahead and dig into a possibly long adventure under the dashboard? The sound lasts 5 seconds, and my wife (it's her car) says it goes away once the car is warmed up.**

It's probably air in the heater core. Usually, this air will eventually work its way into the overflow, so I'd start by making sure there's enough coolant in the system. Some vehicles have cooling systems with air-bleed valves that must be purged when the system is filled—but your Camry doesn't. I'd also check the pressure cap to be sure it's properly venting coolant to the overflow tank and allowing coolant to return to the radiator as the system cools off.

Do this by waiting for the car to cool off and removing the radiator

pressure cap. If your car has a pressurized overflow reservoir, this cap will be on the reservoir and there will be a smaller cap on the radiator itself. If the reservoir is unpressurized, the pressure cap will be on the radiator. Remove the cap on the radiator regardless. The radiator should be full to the brim. If not, check for a bad cap, a leaky hose between the reservoir and radiator, a damaged radiator filler neck or a cracked tank.

## Rust Never Sleeps

**Aside from Saturn, who else among the big car manufacturers makes cars with polymer bodies?**

Tired of watching your steel-bodied car rust away in front of your very eyes? There are a few vehicles on the market today with nonmetallic body panels, mostly pickup trucks with plastic beds and the odd boutique car. GM stopped making its plastic-bodied dust-buster minivans a few years back. Saturn is turning away from plastic as well. That leaves only Corvette (and Cadillac XLR, based on the Vette frame and suspension). Sounds like a good alternative to a rusted-out Cutlass to me. Otherwise, plastic body panels are used mostly for front and rear fascia and bumpers.

**Power to the People  
Ice and snow storms leave thousands without electrical power, running around trying to find 110-volt generators. I was wondering if a 12- to 110-volt inverter would be sufficient to run a heater of 12 amps at 110 volts, or how to size one that won't cause damage to a car's electrical system.**

Most automotive electrical systems should be able to handle a few amps of extra draw in an emergency. Specifically, the 12 amps you mention sounds suspiciously like the exact current draw of a 110-volt electric space heater, which draws way more than a few amps. Let's do the math.

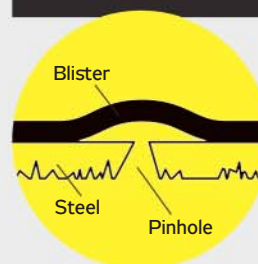
Your heater draws 12 amps at 110 volts, for a total of 1320 watts of

power. So a 1500-watt inverter should be able to run one with no problem, although I'd look to use one rated for at least 2000 watts, to have a little headroom. So we'll need to draw roughly 1500 watts from the car's electrical system to run the heater and make up for losses in the inverter (which is not 100 percent efficient).

At a nominal 13.5 volts, the normal voltage in a car electrical system, we'll

### ■ HOW IT WORKS

## Rust Never Sleeps



It was a terrific paint job, home from the spray booth so recently that you could still smell the enamel reducer in the garage. I always like to see vintage cars, in this case a '62 Dart, well-restored by their owners, so when the proud father showed it to me, I could only hand out compliments on his bodywork.

He called me back to his house a few months later, complaining that the paint shop hadn't properly prepped before spraying it, spawning a half-dozen dime-size blisters in the paint. I popped one with my thumbnail, and water trickled down the fender. The problem wasn't the respray—it was his bodywork. Slapping body filler over a rusty panel can't keep water from seeping into pinholes and lifting the paint from behind. He just assumed a coat of paint over the rust on the interior of the panel would keep the "orange cancer" at bay. Nope, you need to sandblast and chemically prep rusty metal or the rust just keeps on coming back.



need to deliver (gulp!) 111 amps to the input of the inverter. The alternator almost certainly won't make the 10 to 20 amps it needs to run the ignition, injection and fuel pump and also supply this massive amount of current, especially at idle. Many vehicles have only 60-amp alternators. Some vehicles may have alternators rated at over 100 amps, but they aren't intended to operate there for long periods of time. I'll just mention in passing that the wiring between the battery and the inverter will have to be the size of your little finger to carry that much current. Also, you'd need to spin the engine at well above idle to do this, and that will require some mechanical means of racing the engine. A casual nickel inserted into the throttle stop won't cut it.

Bottom line: You can easily suck a few hundred watts of power off the car's electrical system to run a couple of lights or maybe a small TV set, but running anything of substance—like a heater—is going to require a generator designed for the task.

## What's That Smell

**I recently replaced the radiator in my 1989 Firebird Trans Am. When I turn on the heater or defroster I get a faint smell of antifreeze. It's a terrible odor, so I don't even turn the heat on**

**GOT A CAR PROBLEM?**  
Ask Mike about it.  
Send your questions to  
[pmautoclinic@hearst.com](mailto:pmautoclinic@hearst.com)  
or to Car Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.

## anymore. What's the problem with my cooling system?

I want to know why you needed to replace the radiator. Actually, I don't. That unmistakable maple-syrup-and-Turkish-bath smell wafting out of your heater is almost certainly from a leaky heater core, corroded by the same neglected coolant that dissolved your

radiator from the inside out in the first place. You might try to staunch the flow by pouring some stop-leak into the radiator—but that's a temporary fix at best. Sooner or later (probably sooner) you'll need to replace the heater core. But know that this is a big job—the core is buried, deep inside the plenum under the dash.

**PM**

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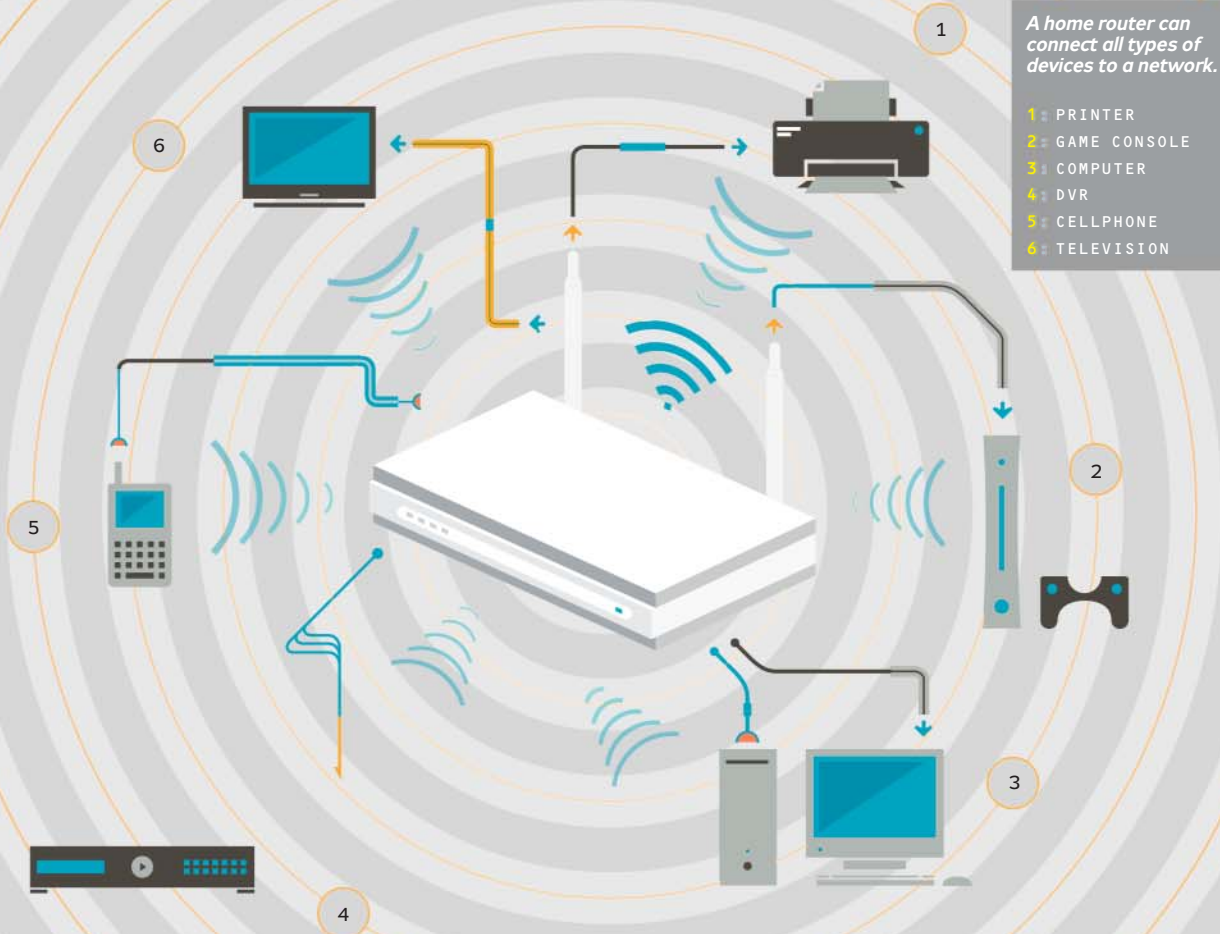
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# DIY Tech



## Making the Most of Your Router

WITH A BIT OF TINKERING, A HOME WIRELESS ROUTER CAN DO MORE THAN JUST BRING A COMPUTER ONLINE. BY ANTHONY VERDUCCI

**Not so long ago**, most home wireless routers were one-trick ponies, rarely used for anything other than bringing PCs online. Today, a router hooked up to a well-managed home network can connect all sorts of devices. In my house, I've got four

computers, three TVs, three game systems, a DVR and a Blu-ray player—all linked into the network. If an always-on data stream is a network's lifeblood, a router is its heart, pumping life throughout the system.

The typical rig may not be quite

as extreme as mine, but the fundamentals of setting up a router on a home network are always the same. With just a little bit of tinkering, anyone can secure a network from hackers (something too few people bother to do), make a router work



faster and more reliably and even unlock a few surprising features. And you can do it all in under 30 minutes.

### Picking a Router

There are dozens of routers on the market, and telling them apart can be difficult. If you want to get the most out of your device, look for one that has USB jacks (not all do), is able to handle Network-Attached Storage (NAS) devices (which basically are hard drives accessible to any computer on the network) and works as an iTunes server (so you can stream songs throughout the house). The fastest routers are 802.11n-compatible. These routers can broadcast over 100 megabytes per second—about twice the maximum output of the older 802.11g routers. Although not every computer can take advantage of these high speeds, most new ones can.

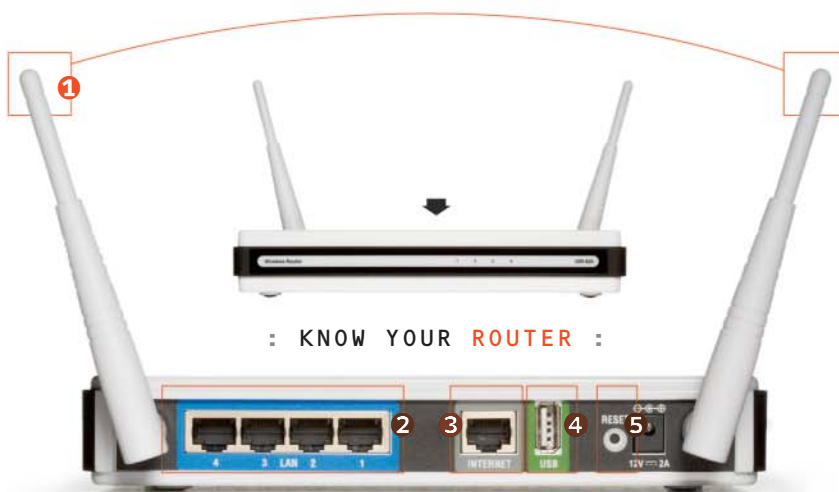
And if, like me, you intend to stream high-definition movies around the house, look for a dual-band router that simultaneously broadcasts both 2.4-GHz and 5-GHz frequencies. The 2.4-GHz band is also used by devices such as microwaves and Bluetooth headsets, so it is prone to interference. That makes the less crowded 5-GHz band a better choice for data-intensive applications such as HD streaming.

### Basic Setup

For a router to work, it must receive a connection from a modem. So, here's the first step: Plug it in. First to a wall outlet, and then to your modem (by plugging an Ethernet cord into the router's Internet jack).

That's dead simple, right? Unfortunately, many people stop right there—leaving their network exposed to hackers, and missing out on many of a router's most powerful features. So the next step should be to log into your router's control panel. This is essentially a Web page that is only viewable on computers that are connected to your router, serving as a home base for all of the device's settings.

To get into the control panel, type the router's IP address into the address bar in your Web browser. Out of the box, the default IP address of most routers is either "192.168.1.1"



#### 1. **Antennas**

The best routers have two antennas—one that broadcasts on the widely used 2.4-GHz band, and one that uses the less-crowded 5-GHz band.

#### 2. **LAN Jacks**

Plugging devices directly into local area network jacks ensures faster, more reliable connections than Wi-Fi. This is ideal for immobile devices such as desktop PCs, TVs and set-top boxes.

#### 3. **Internet Jack**

This is where the router gets its data before dispersing it across a network. Connect this jack to your modem using an Ethernet cable.

#### 4. **USB**

Plugging peripherals such as Network-Attached Storage (or NAS) devices and printers into a router's USB slot allows any computer on your network to access them.

#### 5. **Reset**

If you tinker too much with the settings or lose your password, pressing the reset button will undo the damage and return the router to its factory settings.

or "192.168.0.1." If those don't work, your router's exact address can be found by looking in the manual or on the manufacturer's Web site. When you try to access the control panel, you will be asked for a password. By default this is usually "admin" or merely blank. No luck? Once again, the right information can be found in the router's manual or on the manufacturer's Web site. Once you've logged in to the control panel, you can start having some fun.

### Changing the Network Name

The first step is to simply give your network a unique name. This isn't just for fun—it can also help ward off hackers. A network's default name often includes the name of the router's manufacturer ("linksys" may be the single most common network name), and if hackers know this information, it can be easier for them to sneak into a system. To rename it, look for a setting called Service Set Identifier, or SSID—and be creative and unpredictable.

### Security

Whenever I run into an open wireless network, I have a sense of accomplishment—I like the feeling of getting something for nothing. But this exuberance is somewhat muted by the knowledge that whoever left the network open to me also left it open to hackers. (For a skilled hacker, it's only a short jump between logging onto a network and intercepting personal data from it.) There are other problems with leaving your network open, too—strangers can log in and use up your bandwidth, and if somebody uses the network for anything illegal, you could be left liable. My point: Password-protect your network.

Select your router's security protocol. This setting can be found on a control-panel page called Wireless Security. Wireless networks use two types of security protocols: Wired Equivalent Privacy (WEP) or Wi-Fi Protected Access (WPA). Of the two, WEP is older, more vulnerable to hackers and harder to set up. So if your router gives you the option

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(some older ones don't), choose WPA.

Now you'll need to pick a password. This can be done on your control panel's Wireless Settings page. Unlike other passwords (see page 120), there's no real downside to saving this information in your computer, so you don't need to pick one that's easy to remember. This gives you the freedom to make it as long and unpredictable as possible. Also, write the password down and tape it to the bottom of your router. (If you happen to lose the password and get locked out of your network—it's happened to us all—pressing the hard reset button on your router will cause it to revert to its factory settings and allow you to regain entry.)

Now you've secured the network, but someone could still get into the router's control panel and undo your security. Routers typically use one of a few default passwords for control-panel access, so it's important to set a new one. This can be done in the Router Password setting in the control panel. Don't pick the same password that you use to log on to your network—doing so will make it easier for hackers to cause trouble. Again, write the password down and tape it to your router.

### Updating Firmware

Like most electronic gadgets and gizmos, a router relies on internal software called firmware. But technology moves fast, and by the time you take your router home and set it up, its firmware could already be out of date. Not only does upgrading to the latest

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version ensure you have the best possible protection against bugs and security holes, but it could also add new features, and even increase the speed of your data connection.

To update your firmware, download the latest version from the manufacturer's Web site. Then, go to the Firmware setting in the control panel and upload the file. The router will reboot itself with the new firmware installed.

### Streaming Music and Printing

If you're anything like me, your digital music collection is scattered across multiple computers. Turning on your router's iTunes server feature allows you to stream songs to any computer hooked up to your network. The best way to do this is to connect a NAS device to one of the router's USB jacks.

After your device is plugged in, any computer logged on to your network can access it as if it were an external hard drive. Create a music folder on the NAS device and drag your entire music library into it. Then, go into your router's control panel and look for a setting called iTunes Server. Switch this setting on. Your music library should now pop up in iTunes on any computer hooked up to the network.

Turning your router into a print server is an equally useful trick—it allows multiple computers to wirelessly share a single printer. First, plug your printer into your router's USB port. You'll need to make sure the printer's driver is installed on every computer on the network, so download the latest one off the manufacturer's Web site. Then, go into the Printer setting on each computer's control panel and set up the router-connected printer.

### Controlling Access

I want my network to be as versatile and convenient as possible at all hours of the day and night—but parents of teenagers may not have the

same priorities. See that control-panel setting called either Access Control or Schedule? It allows you to limit when people can log on—meaning you can shut your network off at night if your kids are choosing surfing over sleeping and studying.

You might also want to limit how much bandwidth your computer is sucking up. This can be useful if, for example, your massive downloads are preventing your Netflix-streaming Xbox360 from delivering smooth video—yes, I learned this the hard way. This can be done through a setting that is usually called Throttling.

### Changing the DNS

When you go to a Web site, you typically see the domain as a word (such as *popularmechanics.com*). But in order to access the site, your computer must first translate the words into a numerical IP address, such as 12.44.22.1. This task is usually done by your Internet Service Provider's Domain Name Server (or DNS), and it doesn't happen instantly—the process can noticeably slow down your Web surfing.

Switching your router from your provider's DNS to another one can speed things up. I like OpenDNS, which keeps a large database of IP addresses that it can instantly summon, allowing pages to load faster.

To use OpenDNS, go to *opendns.com* and follow the setup process. You don't need to download any software—just enter some information about your router. Alternatively, you can perform the same task from your router's control panel—go to the DNS Settings tab and enter 208.67.222.222 and 208.67.220.220 in the two slots. Your Web browsing will now go faster. As a bonus, the free service will automatically correct typos—it knows that *popularmechanics.com* really should read *popularmechanics.com* and will send you to the right place.

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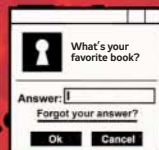
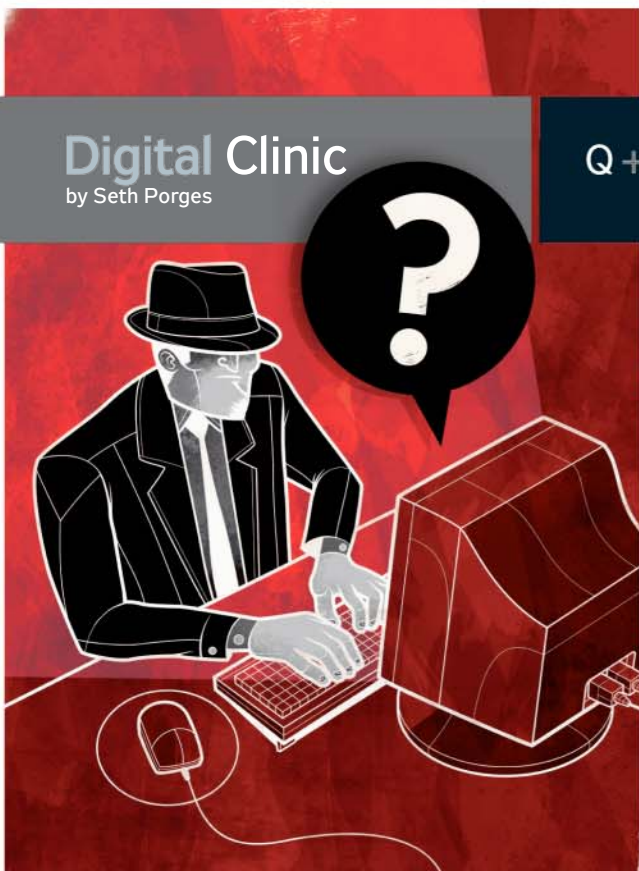
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## Digital Clinic

by Seth Porges

Q + A

### The Security-Question Back Door



← Password-retrieval "security questions" can serve as a hacker-friendly back door into your Web mail.



← The answers to these questions can often be found by searching in Google or looking at your Facebook profile.



← To ward off would-be snoopers, give false answers. If given the option, make up your own, less obvious question.

## Securing Web Mail

**Q** I rely on Web-based e-mail, but am worried about how secure these services are. Is there anything I can do to protect my mail against hackers and digital snoopers?

**A** It's easy to understand the appeal of Web-based e-mail services such as Gmail, Windows Live Hotmail and Yahoo Mail. They are free, offer several gigabytes of storage and are accessible from virtually any computer or smart-phone with a link to the Web. And nearly everybody uses them. But in order to enjoy them, users must take a leap of faith. After all, the services store mail on distant servers, and the fact that you can access your account anytime and anywhere means that somebody else potentially could as well—as headlines reminded us last September, when vice presidential candidate Sarah Palin's Yahoo Mail account was hacked. What's more, if your account does become compromised or you lose your password, it can be nearly impossible to get a tech-support agent on the phone—a shortcoming that is to be expected from any free service that is used by millions of people. So Web-mail users need to be especially careful when it comes to their cyber security. Here's how.

### Picking a Password

Your password is your first and only line of defense against snoopers, so you'd better make it a good one. That means avoiding any words that can be found in a dictionary. One hacker technique involves using programs that

automatically try every word in the dictionary as a potential password. This is why the best passwords utilize a mix of letters (preferably both upper and lower case), numbers and symbols (if your service allows them). As difficult as it is to remember a dozen different

passwords, resist the temptation to use the same password for e-mail that you do for other programs—all it would take is one hacked account to wreak immeasurable havoc on your life. To make remembering multiple passwords easier, try to find a way to incorporate the name (or first few letters) of a site or service into the password. Just make sure it is not done in a way that would be obvious to somebody who might stumble upon your password. For example, maybe make the fourth letter of your password the same as the last letter of the Web site you are using.

### Securing Your Questions

Although security questions aren't as obvious as they once were (mostly gone are the days of "What's your



mother's maiden name?"), questions such as "What is the name of your favorite book?" (currently offered by Yahoo Mail) can still be cracked by somebody with initiative and an Internet connection. The answer may even be in your Facebook profile. And if you happen to be a high-profile personality, the answers are often little more than a Google or Wikipedia search away (this is how the hacker broke into Sarah Palin's account). That's why you should never, ever, answer these questions truthfully. And if you can, write your own security question (most of the free Web-mail services give you this option), and make sure it's something that can't be found by looking at your high school yearbook.

### Raising the Security Level

Of the three most popular Web mail services, Gmail has the best security—it's the only one that gives you the option to encrypt all of your mail using a standard called Hypertext Transfer Protocol Secure (or https). However, this encryption, which makes it difficult for digital snoopers to intercept your messages from open Wi-Fi hotspots, is turned off by default. To switch it on, click Settings on the top of your Gmail page. On the General tab, scroll down to where it says "Browser connection" and select "Always use https." Alternatively, you can just type "https://www.gmail.com" (notice the "s") into your address bar to bring up a secure version of the site. This encryption may cause Gmail to load a bit slower, but it is worth it, especially if you are using a public hotspot.

Hotmail and Yahoo Mail also offer https encryption, but only for the user name and password in your log-in page—your actual messages are still vulnerable. In Yahoo Mail, this setting is always on. For Hotmail, you can turn it on by clicking the button that says "Use enhanced security" below where you enter your password.

If security is a serious concern for you, consider using the Hushmail Web-mail service, which uses more advanced encryption. The service's free accounts limit you to just 2 MB of storage, with larger (and more useful) accounts costing about \$35 per year.

One last point: Web-mail services can keep users logged in for a very long time after you quit the browser. Sometimes weeks. So make absolutely sure you log out of your e-mail when you are done—especially if you are using a public or shared computer. To be sure you are logged out, browse back to your Web-mail log-in page. And even though most Web browsers allow you to store your user name and password in a "keychain" that automatically inserts them when you return to the site, be wary of this. Even if you are the only person who uses your computer, laptops can get lost or stolen—and if that happens your log-in info will go with it.

### Broadcast TiVo

**I recently canceled my cable. Can I still use TiVo to save over-the-air television?**

You sure can, but, thanks to the country's coming conversion to digital TV, owners of older TiVos will need some additional hardware. If you've got a newer Series3 TiVo, all you'll need to record live broadcasts—including over-the-air high-definition channels—is an antenna. If you have an older Series2 TiVo, you'll also need an external digital recorder box (the same sort older TVs will need to receive over-the-air broadcasts after the digital TV transition), and you won't be able to record in HD. Either way, just because you are living without cable doesn't mean you need to live without the convenience of a decent DVR.

### Playing Catch-Up

**I have a PlayStation 2. It works fine through a standard-definition TV. However, when I play it through an HDTV, there appears to be a small lag between when I press a button**

**and when it registers on the screen. What's going on here?**

Most high-definition TVs (with CRT TVs being a notable exception) have a fixed resolution—that is, they always display the same number of pixels, no matter what source they are outputting from. Of course, not every DVD, video game and TV channel matches this so-called native resolution, which means TVs sometimes have to convert video to the proper resolution before it can be

displayed. Older game systems, such as the PlayStation 2, have a native resolution of 480i for most games. Because this matches the native resolution of a standard-definition TV, it works perfectly. But because HDTVs typically have native resolutions of 720p or higher, they must convert the output before they can show it. This process is quick, but it is not instant, and you may notice a lag—particularly with games such as *Guitar Hero* that rely on split-second timing.

Video-game developers have begun to recognize this problem and have taken steps to fix it. Most PlayStation 3 and Xbox 360 games allow gamers to choose the output resolution that matches their TV. These systems will also output PlayStation 2 and original Xbox games at the resolution of your choice. And while there are some additional steps you can take to diminish this problem—try setting the TV to Game Mode (if it has one) to speed up the scaling—the best solution may be to pull the old tube TV out of the closet.

**PM**

**HAVE A TECHNOLOGY PROBLEM?** Ask Seth about it. Send your questions to [pmdigitalclinic@hearst.com](mailto:pmdigitalclinic@hearst.com) or to Digital Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer every question individually, problems of general interest will be discussed in the column.

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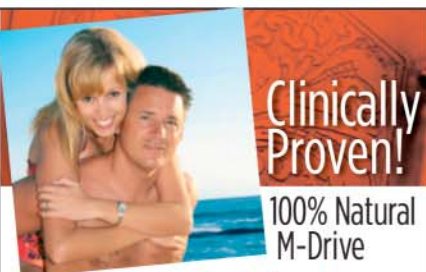
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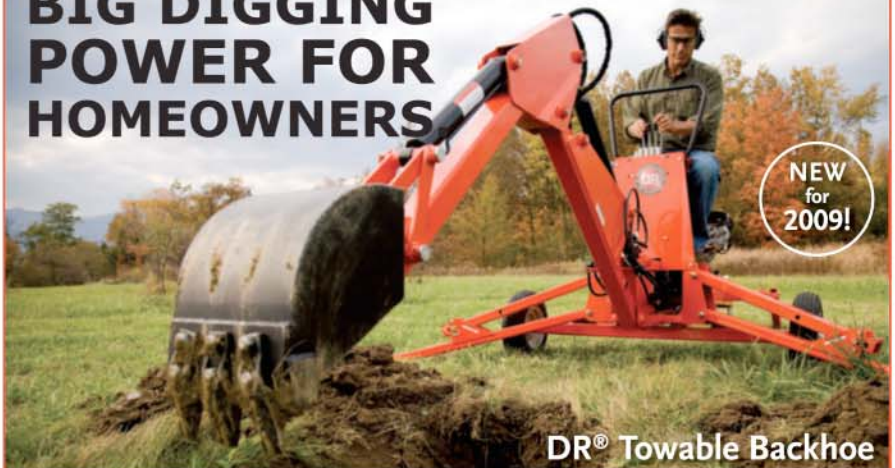
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# THIS IS MY JOB

FISHERMAN

> JEFF WHITE

> LOCATION: YORK HARBOR, ME

> AGE: 38

> YEARS ON JOB: 20

**1. Boat** White built the *Jacquie Andi Nicole* (named for his three daughters) in his driveway in 2004. It has a 40 x 15-ft fiberglass hull and is powered by a John Deere 235-hp six-cylinder diesel engine.

**2. Lobster Trap** In the spring and summer White uses a "pair"—two 13 x 21 x 48-in. traps attached to one buoy—to collect his lobster haul. The traps are usually set about 60 ft apart, baited with salted herring and checked once a week. To collect ground fish, which live on the ocean floor, White uses two 6.5-in. stand-up gillnets made of diamond-shaped mesh.

**3. Hydraulic Haulers** Two hydraulic haulers hoist the lobster traps and nets filled with fish from the water to the boat's deck. Traps are lifted from the starboard side and the gillnets are lifted from port.

**4. Plotter** White uses two GPS-driven plotters, a Simrad and a Si-Tex, as guides while fishing. The units use electronic charts to detect rocks and shoals, sounding an alarm if the boat gets too close.

**5. Underwater Surveillance (inside cabin)** White uses radar with a 48-mile range and a 10-in. video screen to look for other boats and buoys. A 10-in. video sounder helps him predict where the fish will be. Still, "It only shows where they've been, not where they're going," he says. "It's not an ATM card. You don't get something out every time you use it."



The happiest two days of Jeff White's life were when the parts to build his 40-ft lobster boat arrived at his house—and when they finally left as a completed craft seven months later. The independent fisherman fills traps with lobsters and gillnets with ground fish such as pollock, cod or monkfish. Now 38 years old, he began fishing as a child with his father and took to the water alone at 13, fetching lobster traps during the summer. White and his one-man crew are on the water each day from 5 am to midafternoon, as far as 15 miles from shore. "Fundamentally, it's a hunter-gatherer thing," he says. "You can't do this if you don't love it." — ALLIE TOWNSEND





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